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DEVELOPMENT OF MEASURES OF PERFORMANCE FOR EVALUATING THE COMDAT TECHNOLOGY DEMONSTRATOR: POTENTIAL USE OF TRAINING RECORDS FROM THE OPERATIONS ROOM TEAM TRAINER (ORTT)

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Abstract

This report compiles the information contained in three Technical Memoranda pertaining to the development of Measures of Performance (MOP) for Multi-Sensor Data Fusion technology (MSDF), and evaluates logistics and the utility of the Operations Room Team Trainer (ORTT) to gather these MOPs. Each Technical Memorandum is preceded by a summary of its content. This report recounts the development of a strategy for collection of MOPs, the conduct of a proof-of-concept trial at ORTT (with attendant identification of potential improvements to the data collection strategy), and the investigation of methods to reduce the logistical and availability problems associated with obtaining access to Subject Matter Experts (SME). As a result of this work, a further, full-scale, investigation of the archived ORTT performance data to provide performance data for the COMDAT Technology Demonstration Programme was recommended.

Résumé

Le présent rapport comprend une compilation de l'information contenue dans trois documents techniques portant sur l'élaboration de mesures du rendement de la technologie de la fusion de données multicapteurs (FDMC), ainsi qu'une évaluation de la logistique et de l'utilité du simulateur pour l'équipe de la salle des opérations (SESO) en vue de la collecte des mesures du rendement. Chaque document technique est précédé d'un résumé de son contenu. Le présent rapport récapitule l'élaboration d'une stratégie de collecte des mesures du rendement, la conduite de l'essai de validation de principe au SESO (l'opérateur identifiant les améliorations possibles à apporter à la stratégie de collecte des données) et l'examen des méthodes visant une réduction des problèmes de logistique et de disponibilité associés à l'accès aux experts en la matière (EM). Suite à ce travail, un autre examen pleine échelle des données archivées sur le rendement du SESO a été recommandé en vue de la fourniture de données sur le rendement dans le cadre du programme de démonstration de la technologie d'aide aux décisions de commandement (COMDAT).

Executive Summary

Over the past several years, Humansystems Incorporated® (HSI®), under a succession of contracts managed by DRDC-Toronto, has identified the critical functions and their associated human behaviours that are the core components of effective Command and Control (C2) performance in the Operations Room of the Halifax Class frigate. The work commenced with a Cognitive Task Analysis (CTA) of the Operations Room Officer (ORO), using a scenario based methodology, to determine the major functions performed by the ORO. The analysis focussed on situation awareness, communication, decision making and workload. Subsequently, with the emergence of the COMDAT TD, HSI was tasked to develop appropriate Measures of Performance (MOPS) based upon the CTA that would be appropriate for assessing the impact of the TD on operational performance. In addition, HSI was requested to develop a Test and Evaluation (T&E) Trial Plan and to evaluate sites and opportunities where appropriate performance data might be collected.

Several independent reports and technical memoranda resulted from this work, and, although complete in themselves, they do not provide a comprehensive view of the work that has been done. Therefore, DRDC-Toronto has requested that the reports be organised into two collections: one based largely on studies relating to the NCOT facility, the other relating to the Operations Room Team Trainer (ORTT).

Three documents are first summarised and then presented in full in this composite report:

The first report: "*Technical Memorandum*: *Follow-Up Evaluation of the Operations Room Team Trainer as a Test Environment for Collecting MOP Data to Support COMDAT*" provides an overall context for the remaining reports. It deals with an alternative method for gathering MOP data to support the COMDAT Technology Demonstration Project. This method involves analysing archived performance data, requiring less logistical coordination and control over the ORTT. This Technical Memorandum reports the initial assessment of using ORTT training records as a potential source of COMDAT relevant MOPs, based on the observation of an actual team training exercise and evaluation of the real-time data record.

The second report: "*Technical Memorandum: Assessing the Impact of Multi-Source Data Fusion on Command and Control Operations in the Halifax-Class Frigate: Use of the Operations Room Team Trainer (ORTT) Training Records to Extract Quantitative and Diagnostic Measures of Performance"* reports on a detailed proof of concept evaluation of the ability to extract COMDAT TD relevant MOPs from archived records created during ongoing Navy training scenarios in the ORTT. This work was expected to provide a definitive direction for future T&E trials concerning the use of either NCOT or ORTT facilities.

The final report "*Technical Memorandum: Provision of Naval SME Support to Contractors"* addresses the need for Subject Matter Experts for blocks of time to participate in trials or to meet with contractors to explain operational procedures and processes. This Technical Memorandum addresses problems in obtaining this access and seeks to find a way to lessen demand and administrative burden whilst still providing the required SMEs to contractors.

The interested reader is recommended to read this compilation report together with the companion report "Development of Measures of Performance for Evaluating the COMDAT Technology Demonstrator: Potential Use of the Naval Combat Operator Trainer (NCOT) for Data Collection" in order to be fully informed regarding the development of MOPs and the selection of appropriate venues in which to gather MOPs for the COMDAT TD.

Sommaire

Depuis plusieurs années, Humansystems Incorporated® (HSI®) a, en vertu d'une série de contrats administrés par RDDC Toronto, identifié les fonctions critiques et les comportements humains connexes qui constituent les éléments fondamentaux du commandement et du contrôle (C2) efficaces dans la salle des opérations de la frégate de la classe Halifax. Le travail a commencé par une analyse cognitive des tâches de l'officier de la salle des opérations, au moyen d'une méthodologie fondée sur divers scénarios, dans le but de déterminer les principales fonctions exécutées par l'officier de la salle des opérations. L'analyse a porté principalement sur la connaissance de la situation, la communication, la prise de décisions et la charge de travail. Par la suite, avec l'émergence du démonstrateur de la technologie d'aide aux décisions de commandement (COMDAT), HSI a été chargée d'élaborer les mesures du rendement appropriées, d'après l'analyse cognitive des tâches convenant à l'évaluation de l'incidence du démonstrateur de technologie sur le rendement opérationnel. On a aussi demandé à HSI de préparer un plan d'essai et d'évaluation (E et E) et d'évaluer les emplacements et les occasions où des données appropriées sur le rendement pourraient être recueillies.

Plusieurs rapports et documents techniques distincts ont été produits au terme de ces travaux et, même s'ils sont complets en soi, ils ne donnent pas une vue d'ensemble du travail effectué. C'est pourquoi RDDC Toronto a demandé que les rapports soient regroupés en deux séries : une série fondée principalement sur les études relatives au simulateur d'opérateur d'équipement de combat naval (NCOT), et l'autre portant sur le simulateur pour l'équipe de la salle des opérations (SESO).

Trois documents sont tout d'abord résumés, puis présentés dans leur version intégrale dans le présent rapport global :

Le premier rapport, intitulé « *Technical Memorandum*: *Follow-Up Evaluation of the Operations Room Team Trainer as a Test Environment for Collecting MOP Data to Support COMDAT* », présente le contexte d'ensemble des autres rapports. Il porte sur une autre méthode de collecte de données de mesure du rendement à l'appui du projet de démonstration de la technologie COMDAT. Cette méthode comprend l'analyse de données archivées sur le rendement, ce qui requiert moins de contrôle et de coordination logistiques en ce qui concerne le SESO. Ce document technique fait état de l'évaluation initiale de l'utilisation des dossiers d'instruction du SESO comme source potentielle de mesures pertinentes du rendement de la technologie COMDAT, d'après l'observation d'un exercice réel d'instruction d'une équipe et l'évaluation du dossier de données en temps réel.

Le deuxième rapport, intitulé « *Technical Memorandum: Assessing the Impact of Multi-Source Data Fusion on Command and Control Operations in the Halifax-Class Frigate: Use of the Operations Room Team Trainer (ORTT) Training Records to Extract Quantitative and Diagnostic Measures of Performance* », présente une évaluation détaillée de validation de principe de la capacité à extraire, des dossiers archivés créés dans le SESO durant les scénarios d'instruction en cours de la Marine, les mesures pertinentes du rendement du démonstrateur de la technologie COMDAT. Ces travaux devaient permettre de donner une orientation définitive aux futurs E et E concernant l'utilisation du NCOT ou du SESO.

Le dernier rapport, intitulé « *Technical Memorandum: Provision of Naval SME Support to Contractors* », porte sur la nécessité de retenir les services d'experts en la matière (EM) pendant des périodes de temps en vue de leur participation aux essais et de rencontres avec les entrepeneurs dans le but de leur expliquer les procédures et les processus opérationnels. Ce document technique traite des

difficultés d'accès aux EM et cherche à trouver un moyen d'amoindrir la demande et le fardeau administratif, tout en assurant les services d'EM.

On recommande au lecteur intéressé de lire le présent rapport de compilation et le rapport connexe, intitulé « *Development of Measures of Performance for Evaluating the COMDAT Technology Demonstrator: Potential Use of the Naval Combat Operator Trainer (NCOT) for Data Collection* », pour obtenir une information complète sur l'élaboration des mesures du rendement et la sélection des emplacements appropriés en vue de la collecte des mesures du rendement du démonstrateur de la technologie COMDAT.

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1. Introduction

Over the past several years, Humansystems Incorporated (HSI), under a succession of contracts managed by DRDC-Toronto, has identified the critical functions and their associated human behaviours that are the core components of effective Command and Control (C2) performance in the Operations Room of the Halifax Class frigate. The work commenced with a Cognitive Task Analysis (CTA) of the Operations Room Officer (ORO), using a scenario based methodology, to determine the major functions performed by the ORO. The analysis focussed on situation awareness, communication, decision making and workload. Subsequently, with the emergence of the COMDAT TD, HSI was tasked to develop appropriate Measures of Performance (MOPS) based upon the CTA that would be appropriate for assessing the impact of the TD on operational performance. In addition, HSI was requested to develop a Test and Evaluation (T&E) Trial Plan and to evaluate sites and opportunities where appropriate performance data might be collected.

Several independent reports and technical memoranda resulted from this work, and, although complete in themselves, they do not provide a comprehensive view of the work that has been done. Therefore, DRDC-Toronto has requested that the reports be organised into two collections: one based largely on studies relating to the Naval Combat Operators Trainer (NCOT) facility, the other relating to the Operations Room Team Trainer (ORTT). Thus, in order to obtain a comprehensive and integrated perspective on the work that has been accomplished, the reader is encouraged to review both reports.

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2. Report organization and summary of contents

The main body of this report provides a summary of each of the previously independent reports, followed by each report itself. Where necessary, and for clarity, linking paragraphs between reports have been provided. An overall summary of the reports is provided at the end of the document.

The first report: "*Technical Memorandum*: *Follow-Up Evaluation of the Operations Room Team Trainer as a Test Environment for Collecting MOP Data to Support COMDAT*" provides an overall context for the remaining reports. It deals with an alternative method for gathering MOP data to support the COMDAT Technology Demonstration Project. This method involves analysing archived performance data, requiring less logistical coordination and control over the ORTT. This Technical Memorandum reports the initial assessment of using ORTT training records as a potential source of COMDAT relevant MOPs, based on the observation of an actual team training exercise and evaluation of the real-time data record.

The second report: "*Technical Memorandum: Assessing the Impact of Multi-Source Data Fusion on Command and Control Operations in the Halifax-Class Frigate: Use of the Operations Room Team Trainer (ORTT) Training Records to Extract Quantitative and Diagnostic Measures of Performance"* reports on work whose goal was to conduct a detailed proof of concept evaluation of the ability to extract COMDAT TD relevant MOPs from archived records created during ongoing Navy training scenarios in the ORTT. This work was expected to provide a definitive direction for future T&E trials concerning the use of either NCOT or ORTT facilities.

The final report "*Technical Memorandum: Provision of Naval SME Support to Contractors"* addresses the need for Subject Matter Experts for blocks of time to participate in trials or to meet with contractors to explain operational procedures and processes. This Technical Memorandum addresses problems in obtaining this access and seeks to find a way to lessen demand and administrative burden whilst still providing the required SMEs to contractors.

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3. Technical Memorandum:

FOLLOW-UP EVALUATION OF THE OPERATIONS ROOM TEAM TRAINER AS A TEST ENVIRONMENT FOR COLLECTING MOP DATA TO SUPPORT COMDAT

3.1 Summary

3.1.1 Background

The original assessment of the ORTT as an environment in which to collect MOPs for Ops Room functions was based upon the premise that specialised T&E trials would be the means by which data would be collected. The large logistical overhead and support from the Navy required for mounting such a trial in the ORTT was considered to be a major practical barrier. Therefore, attention was focussed primarily on NCOT as a facility to collect small team MOPs. A number of investigations relating to the feasibility of using NCOT are documented in a parallel report "*Development of Measures of Performance for Evaluating the COMDAT Technology Demonstrator: Potential Use of the Naval Combat Operator Trainer (NCOT) for Data Collection".* As a result of the NCOT work, several technical limitations concerning NCOT data collection and analysis, together with the artificiality[1] of the context for evaluating COMDAT related Ops Room team performance, led to a re-consideration of the ORTT for data collection. However, instead of viewing the ORTT as environment for a dedicated T&E trial as originally conceived, the idea of extracting MOPs from archived ORTT records captured during sophisticated Navy training scenarios was thought to be a promising avenue of approach. Such training scenarios involve intact Ops Room teams, with suitable levels of training and experience and provide a high-fidelity experience involving multi-warfare threats in a Canadian Task group/littoral water environment.

This Technical Memorandum reports the initial assessment of using ORTT training records as a potential; source of COMDAT relevant MOPs, based on the observation of an actual team training exercise and evaluation of the real-time data record.

3.1.2 Findings

The observation team from HSI® identified nine goals for their visit to ORTT. They were:

- Observe a team training exercise;
- Evaluate the opportunities for data capture;
- Assess the suitability of existing ORTT training scenarios;
- Assess the playback ability of ORTT;

[1] Teams are separated from the normal Ops Room and Task Group wide interactions that form a critical component of mission execution and the level of communications is artificially low.

- Evaluate the suitability of ORTT for T&E data collection;
- Determine whether MOP data can be extracted from archived data;
- Assess the subject populations for their suitability for T&E purposes;
- Assess the ability of ORTT to support T&E trial logistics; and
- Make suggestions for future test trials.

There were a number of features observed in the ORTT that could impact future attempts to use it for collection of MOPs. One of the most important was the requirement to use existing ORTT exercise scenarios. This could potentially limit the project's ability to target COMDAT TD specific behaviours for analysis. Also, any exact repetition of specific scenario threat events for comparative purposes could be difficult to achieve due to the real-time reactive actions of game controllers.

A detailed feasibility assessment was conducted of which MOPs could be collected in the ORTT (based upon the MOPs evaluated initially in NCOT) and what aspects of the COMDAT TD would require the development of new MOPs. An additional four MOPs were created to meet this need, in particular for the context of 'double-tracking' (a recurring operational problem for which MSDF is a potential solution).

It was determined that ORTT imposes more realistic workload on the ORO, than could be created in NCOT and the level and content of communications between team members were also more representative of the operational context. Scenario development for the ORTT for T&E purposes would not require T&E team resources, given the existence of robust training scenarios. One major advantage of the ORTT was that the typical scope of scenarios involved full co-operation among the Ops room team and other TG units and there were many repetitions of the detect-to-resolve cycle.

Data recording in ORTT was also found to be more comprehensive, robust and reliable than in NCOT. Further data playback capabilities in the ORTT for the purposes of analysis and MOP extraction represented a major improvement over NCOT. Further, logistical support in the ORTT for T&E purposes is more comprehensive and cheaper, assuming MOP data collection is integrated with existing training exercises.

There were some potential concerns that the ORTT might not be able to provide enough experimental control over the scenario events. Hence, it was recommended that a pilot trial be conducted to address this and other practical issues.

There had also been some concern that security requirements associated with ORTT might make the use of the playback facility for analysis difficult, but as a result of the initial assessment, it was now thought that this would not be a significant barrier, providing the initial analysis and data reduction were done on site at the ORTT.

3.1.3 Conclusions

Based on the factors reported above, it was recommended that work directed at the collection of MOPs using NCOT be ceased, and effort be directed toward the conduct of a pilot trial using the ORTT to assess the suitability of using archived training records as a means of generating COMDAT TD relevant, MOP data.

3.2 Background

In the past year we reviewed alternative test environments including Naval Combat Operator Trainer (NCOT) and the Operations Room Team Trainer (ORTT) for their suitability to permit data collection for test and evaluation purposes (T&E) in support of the COMDAT program (Matthews, Webb, Stager and Keeble, 2001). This review concluded that the NCOT would be the most suitable facility for conducting T&E using single operators performing simple operational functions such as detecting and tracking radar contacts. While more limited in its simulation fidelity than ORTT, for repeated trials of simple tasks, the NCOT facility appears to be the most versatile to configure and the most economical to operate. NCOT allows the collection of T&E data for several operators performing the same task in parallel. NCOT also appears suitable for assessing performance of small teams of 2-4 individuals performing more complex, interacting functions. This assessment was based upon the expectation that the contractor responsible for NCOT would deliver software that supports this level of functionality within the next year.

At the time of the original evaluation, we did not have an opportunity in the ORTT to observe a full exercise in progress or to access any archived data. Nevertheless, we recognised its potential for the assessment and measurement of more complex functions in the Ops Room, including tasks involving interactions between complete warfare teams, interactions between warfare directors and the ORO, and between the ORO, CO and the entire Ops Room team.

Since that time we have conducted a proof of concept evaluation of NCOT (Matthews, Webb and Keeble, 2002) in which we noted several technical limitations with the scenario creation and data playback capabilities of NCOT, which still remain to be resolved. Further, in contrast to previous expectations, no new scenarios had been developed for NCOT that are readily suitable for T&E purposes.

In parallel to the ongoing evaluation of NCOT, and following discussions with the Scientific Authority, it was decided to further investigate the capabilities of ORTT particularly with respect to the possibility of being able to extract T&E data from ongoing Navy training exercises, which use the facility on a regular basis. It was further felt useful to visit the ORTT during an actual exercise to observe at first hand a functionally-operating Ops Room team, since prior analyses and conclusions had been largely based upon reviews of technical documentation, discussions with ORTT and NCOT support personnel and tabletop walkthroughs of scenarios with Ops Room SMEs.

Consequently, a visit was arranged for a Human*systems*® Inc. team (M. Matthews, R. Keeble, L. Bruyn) to attend the ORTT on September 13-14, 2002.

3.3 Goals of the visit

- Observe Ops Room team functions during a live training exercise
- Evaluate opportunities for data capture during exercise
- Examine the suitability of existing scenarios used for training exercises
- Evaluate the ability of the ORTT for data replay to support requirements for T&E analysis
- Re-visit issues on suitability of the ORTT for T&E data collection during training exercises

- Determine whether MOP data could be extracted from archived ORTT exercise training data.
- Assess the subject populations evaluated in the ORTT for their suitability for T&E purposes
- Determine the ability of the ORTT to support T&E trial logistics
- Recommend courses of action for future test trials

3.4 Visit Details

On the first day of the visit, we observed a full Ops Room team comprised of students reaching the end of their the various CFNOS operations courses and who were in final preparation for evaluation. The team comprised the full complement of personnel that are normally found in the ORTT. Some training and support personnel were on hand to intervene with the team should circumstances warrant.

We were able to observe the team in two ways. First: by positioning ourselves towards the side and rear in the Ops Room itself adjacent to the area occupied by the CO and communications station. From this location we could clearly observe most of the activity in the Ops Room without necessarily being able to view the content of CCS displays. Second, we re-located to the adjacent Brief/Debrief suite where we were able to monitor up to three workstations at a time and listen to one Comm net. Other workstations and Comm nets could be readily selected as required. Thus, on the first day we looked at a complete training scenario run-through lasting about 2 hours. We also spent time in becoming familiar with the replay software and video recording capabilities.

We did not ask for, nor have access to, the gaming script and complete gaming package provided to the exercise team including information such as rules of engagement (ROE) and identification criteria etc, although we believe this could be made available if requested.

The entire second day was spent in the Brief/Debrief suite where we reviewed and analysed a previously recorded training scenario that used the same scenario events that we had observed, but involved a different team. Assisting us in the use of the facility were the ORTT manager and another LMC staff member.

3.5 Analysis

3.5.1 Characteristics of personnel assessed in the ORTT

Essentially three types of personnel come to the ORTT for training and assessment. The first group comprises students nearing the end of a particular operations Qualification Level (QL) course ranging from QL 5 to ORO. They spend approximately seven developmental days in the trainer going through a series of scenarios, which culminates with an individual assessment of their abilities to meet the course training standards. This group of individuals would not have worked together as a team before and all are approximately equally inexperienced in the roles for which they are working to qualify.

The second group of trainees involves individuals who are qualified for their Ops Room position but have been away from operational deployment. For these individuals, the ORTT represents a refresher course.

The third group comprises a fully functioning Ops Room team actively deployed in a ship who have come to the trainer to gain additional practice and/or familiarity with specific or new procedures. Examples of this would be preparations for a live missile shoot, or for a deployment to an operational theatre.

Clearly, the first group will have the most technical proficiency in the basic procedures but virtually no experience in applying those procedures at sea. The second group will be somewhat stale in both their technical and operational proficiency. The third group will have more operational experience, but depending upon these experiences and habits formed, may have less technical proficiency in some aspects of using the Ops Room equipment than the first group. This group will also have developed a more complete team mental model than the other two groups, which will impact both upon their intra-team communication and the manner in which they collectively problem solve.

From a future T&E perspective, the optimum subject sample would comprise individuals from group 3. However, the opportunity to compare across teams in the various groups should not be overlooked, since this would provide potentially valuable data on the completeness of the different aspects of their team mental models, including knowledge of tasks, knowledge of other team members, knowledge of the system and knowledge of context.

3.5.2 Characteristics of the training scenario

In general, open water scenarios are used for team training, although a littoral scenario is currently under development. The scenarios involve a typical Canadian Navy task group with three or more Halifax class frigates, one mission essential unit[2], an Iroquois class destroyer and a maritime patrol aircraft (MPA). Scenario background events comprise surface marine traffic and limited commercial flights along high level air corridors. Threat events involve attacks by aircraft and ships firing anti-ship missiles and submarines firing torpedoes.

A typical 2-hour scenario usually has the following elements and comprises three 45-minute segments that focus on air (AAW), surface (ASuW) and underwater (UWW), culminating with a simultaneous threat in two warfare areas:

- 5-6 underwater contacts: (torpedo, whales, wrecks, decoys, friendly & threat sub)
- 30 surface contacts
- Air contacts: approx. 1 every 6 minutes mostly commercial air, no neutral helos, or neutral air

In addition, the scenario support team can manufacture entities as in real time as well as load mini-scenarios within each scenario (all pre-scripted). A description of the planned events for the scenario is available, to which we can have access.

The following table shows some of the major differences in scenario between that typically used in the ORTT for training at that developed by HSI for possible use in T&E in NCOT.

ORTT Scenario	HSI/NCOT Scenario
Open water	Littoral
Low volume, high altitude commercial air	Moderate-high volume, high altitude commercial air

[2] Formerly called "high value unit"

No low altitude commercial air	Moderate-high volume, low altitude commercial air (helos a/c landing and departing from nearby airports)
Low volume, slow moving surface traffic	Higher volume, slow and fast surface traffic
Sub-surface contacts	None
Repeated air threats	Limited number of air threats, many potential air threat situations
Several air-launched anti-ship missile attacks	None
Torpedo attack	None
Engagement of incoming missiles	None
Engagement of attacking a/c	None
Engagement of surface ships	None
Avoidance of incoming torpedo	None
Double tracking can occur when track is held by two sensor systems	Could not successfully simulate
Script is modified in real time by game players to reflect circumstances	Scripted events follow a more precise schedule.

Table 3.1: Comparison of the main features of NCOT and ORTT scenarios

ORTT scenario limitations:

- It is not possible to create a scenario that exactly matches all T&E requirements since ORTT pre-scripted scenarios must be used.
- The scenario will not be exactly repeatable across different test runs and teams, because the game controllers take into account ongoing circumstances and how the team is performing when introducing threat events.

3.5.3 Scenario Record and Playback

The ORTT functionality allows all Ops Room CCS displays and communications to be recorded from the entire team present. Face to face interactions and the passage of paper communications (largely between the ORS and other team members) can be recorded through a separate video and audio monitoring system, using one camera and two microphones to capture the entire Ops Room. Since we judged the current placement of these to be less than optimum for capturing ORS/ORO exchanges, the ORTT manager was willing to explore the possibility of relocating these on a temporary basis for any future T&E trials in the ORTT.

The scenario playback can be monitored in the Brief/Debrief room either on three wall mounted large screen displays or 15" CRT monitors (note: larger monitors could be made available to the test team for analysis/playback purposes). The data replay must be done through the hardware at ORTT.

The ORTT scenario playback function has the following capabilities:

- Can play at half, full and 5 X speed
- Can set flags during scenario execution

- Can tag points in time during playback and make notes for quick location during playbacks
- Can pause and resume at any time
- Can jump playback to a specific time or to a marker
- Can select any three of all the Ops Room CCS workstations for playback
- Can listen to one audio circuit/net at one time (user selectable)

The latter difficulty may be overcome in analysis by repeated runs through critical parts of the playback and listening to different circuits. Alternately, all of the existing soundtracks could be multiplexed onto a tape (during recording) for subsequent simultaneous replay.

In addition to the above, the separate ORTT video and audio record can also be replayed on a separate large screen independently of, or in synchrony with, the CCS/Comm digital data record.

3.5.4 Analysis of recorded scenarios

As noted earlier, analysis of scenarios would have to be conducted at the ORTT Brief/Debrief room. The ORTT manager does not believe that there would be any problem in getting blocks of access time in this room, since it is not widely used by the Navy.

In general, the analysis will be conducted through repeated runs of the scenario record supplemented by separate audio/video record. In order to document and measure the information flow and team actions, we believe that it would be beneficial to develop a Gantt-chart format showing the detailed relationship of scenario events and team actions and communications on a common time line.

One important issue that arises from our present review of the ORTT, is how we would be able to time events of interest with the required precision, given that the time line of the scenario is not scripted to the second. An example of this would be determining the start of each detect-to-resolve cycle[3]. In general, many initial contacts will come from MPA and will therefore first appear on screen as linked tracks; other contacts will come from auto-initiated radar tracks. We believe that if we have the script in hand and can be present in the game control facility during scenario execution, we can readily observe these events and place a T&E marker on the scenario record at the commencement of selected detect to resolve cycles. Thus, during playback we will be able to determine the first point in time at which some form of response or action on any track could have been initiated. Determining the timing of these responses during playback will not be a problem as both the CCS time clock and scenario replay clocks are readily visible. Even if we cannot be present during scenario execution and have to rely solely on determining the start of some events from the playback record, by using cues in the script and closely monitoring the appropriate CCS display where an event is about to occur, we should be able to see the time of first occurrence on the display.

Analysis of non-CCS and non-net-based communications would come primarily from the separate audio-video tape record, which would require manual synchronisation with the ORTT digital record.

[3] The detect-to-resolve cycle is considered a critical task in evaluating MSDF or other decision aid technologies that are aimed at improving the tactical picture and reducing response time to potential threats.

A detailed analysis (similar to the one conducted for the NCOT POC) of how the measurement of specific MOPs would be conducted and is supported by the ORTT is provided in Annexes A and B.

3.5.5 Other Issues

3.5.5.1 Threat responses

Because the ORTT scenarios always require the team to respond to threats, it would be relatively straightforward to incorporate MOPs for this into the analysis process.

3.5.5.2 Dual tracking by radar

Dual tracking by radar is considered a primary problem for which MSDF technology should provide a significant benefit. Prior to the ORTT visit we have not been able to observe how Halifax class radars actually behave in conditions of signal uncertainty and we have not been in a position to prescribe MOPs for dual tracking situations. Having now seen how and when these circumstances occur, we recommend the following additional MOPs:

- Frequency of dual track situations (system-wide measures rather than ORO measure)
- Time to detect and respond to dual track situation
- Total time spent in dealing with dual track situation
- Accuracy in responding to dual track situation (e.g. do they put STIRS on the appropriate track)

3.5.5.3 Preferred subject population

For formal testing, we would prefer to have ship's team coming directly from sea because it would be more likely to represent the skill level to be expected in actual operational performance. This type of team would be in the second phase of training as opposed to initial training and would have developed the critical experience in working together on common procedures.

However, at some future time it would be useful to collect data on all three groups to allow the assessment of how COMDAT may impact upon Ops Room performance with teams at varying stages of training and experience and hence different team mental models.

3.6 Discussion and Analysis

3.6.1 General observations

Our first and most important observation having closely watched an Ops Room team at work for the first time at any length and in any detail, is that the work and performance of the ORO is inextricably bound with the team around him/her. This clearly reinforces the conclusion from the cognitive task analysis (CTA) of the ORO (Matthews, Webb and Bryant, 1999). Many tasks involve a close synchrony of actions, communications and common understandings between the ORO and team members, in particular the CO, SWC, ASWC and ORS. In turn, the reactions and behaviour of the warfare directors are in turn integrated with their respective teams. Thus, attempts to measure the performance of ORO based tasks in isolation from the team could represent a major challenge to the construct validity of such measures. Not only are many of the OROs tasks

embedded within the team functions and actions, but the performance is highly dependent in many cases on the specific actions and effectiveness of the other team members. Therefore, to isolate the ORO and assess him/her in an environment that examines solely his/her own tasks in the context of an unknown and unpractised team (as had been contemplated for NCOT) may be problematic. The ensuing data collected from such an approach may achieve reliability and robustness yet it may lack ecological validity and representativeness of the true operational context.

In comparing the NCOT and ORTT as potential test sites in our previous report, we had recommended NCOT for assessment of tasks involving operators and small teams and the ORTT for the assessment of more complex teams and the full Ops Room. Having now seen how even small sub-teams perform in the wider context of ongoing Ops Room functions, we feel that this initial assessment may need to be qualified. Given the ORO's involvement with the broader Ops Room functions, it does not appear that an NCOT configuration of an air warfare team (or other domain) plus the ORO can be justified when the measurement level of interest is the *ORO*. NCOT would be more suitable for measures addressed at the operator or warfare director level. Further, while the workload for such a team may be satisfactorily simulated in NCOT, the workload for the ORO is unrepresentative, except for those situations where operational circumstances require the ORO to perform the functions of the SWC. As we noted from the CTA, the ORO is primarily a multi-tasker, one moment a manager, another a co-ordinator, another a facilitator, another a planner, another an analyser, another a decision maker etc. To remove the ORO from the context of such workload and attempting to evaluate his/her performance in an isolated sub-team, as had been attempted and planned for NCOT, severely misrepresents the operational circumstances under which the ORO performs. As such, this has the danger of both limiting the generalisability and validity of any performance measures obtained in this way.

3.6.2 Specific points of comparison between NCOT and ORTT

We will now look in more detail at some of the advantages and disadvantages of each environment with respect to the major needs for developing and conducting T&E trials

3.6.2.1 Scenario development

The development of scenarios in NCOT for MOP purposes will require the HSI team to write and code the entire scenario, since none exist at present.

For the ORTT, several blue water scenarios are in place and have been validated through a number of training exercises. Littoral scenarios are under development.

Conclusion: use of the ORTT will save considerable resources and associated costs in scenario development and will provide validated scenarios.

3.6.2.2. Scenario scope

In NCOT, the custom written scenario that HSI has developed is based upon a littoral environment and reflects a relatively low threat to background event pattern. The scenario also involves air and surface contacts. The Ops Room team spends much of its time dealing with background traffic and the scenario may be fairly representative of such operational conditions. The scenario does not involve any direct weapons threats to the ship and requires no action to be taken against potential threats. Radar tracking problems, of the type thought to be of interest to MSDF, are difficult to simulate in NCOT.

The ORTT scenario focuses more on the detection and response to threats in all warfare areas against a lower volume of background events. The scenario escalates to the point where tactical decisions concerning threat priority are forced upon the Ops Room team. Dual radar tracking of targets occurs[4] readily and represents opportunities to document and measure how well MSDF technology improves Ops Room performance.

Conclusion: the HSI scenario, while operationally realistic, provides fewer opportunities for observing the detect-to-resolve-to-react cycle across all warfare domains. Since the focus of COMDAT MSDF technology is to improve the tactical picture, particularly to resolve problems with threat identification and tracking, the ORTT scenario provides a suitable environment for collecting appropriate MOP data.

3.6.2.3 T&E measurement needs

These are outlined in detail in Annexes A and B in the same format as the NCOT POC report. The major difference between the two environments concerns the control afforded the T&E team in NCOT compared with the ORTT. In NCOT the T&E team would be able to inject probes, stop the scenario, ask for SITREPS, communicate with players and control events through the use of "actors" in the warfare teams. None of these capabilities can be achieved directly in the ORTT.

Conclusion: The degree to which the lack of "experimental" control in the ORTT represents a barrier to the collection of the range of MOP data required remains to be documented. The original T&E plan represented a desire to have an *optimum* T&E environment, the question is whether the ORTT will be an adequate environment that *satisfices* T&E needs. It is recommended that this be investigated through a pilot test to determine what useful MOP data can be extracted from archived exercise data.

3.6.2.4 Scenario execution

In NCOT the scenario is executed in the same way every time according to the programmed schedule of events. This has the advantage of repeatability and experimental control, but it remains to be determined whether this can be adequately co-ordinated with ship movements over a two-hour scenario, or whether some T&E team intervention will be required. Such intervention requires expert knowledge in how to realistically place/time the event in question. In the ORTT, the entity controllers follow a general script of events but vary their timing and place of entry into the scenario according to current circumstances of the mission and the ongoing workload of the team.

Conclusion: The reduced ability to precisely control scenario events and to repeat scenarios exactly across trials may be a necessary trade-off against other advantages of the ORTT.

3.6.2.5 Team communication

Aside from the use of a real (ORTT) as opposed to a simulated SHINCOM (NCOT) panel, the ORTT provides the full range of internal and external communications that would be very difficult

[4] We believe that the dual tracking that we witnessed was specific to tracks within the quick-reaction (QR) range, and had more to do with extra track generation than some of the dual tracking situations experienced at sea, where radars may have difficulty in tracking close or violently manoeuvring aircraft. Based upon this single scenario, we are not in a position at this stage to comment upon whether the dual tracking in the ORTT would occur as readily as it would at sea.

to duplicate in NCOT without the use of an extensive support team. Further, it would be difficult to achieve the volume and salience of text messages that are directed to the ORO, largely through the ORS. Further, our observations of the training exercise underlined the degree to which in actual operations that the ORO is constantly changing his communication focus and interactions. While the NCOT POC showed that we could successfully reproduce the communication activity of a small warfare team, this severely underestimates the typical communication load for the ORO in a normal Ops Room. Further, we observed the critical role played by the ORS in supplementing net-based communications in the Ops Room. Such a role and capability would be difficult to implement in NCOT.

Conclusion: The ORTT represents a more realistic and valid context for assessing ORO communication effectiveness both within and external to the Ops Room.

3.6.2.6 Data recording

The data recording capabilities of the ORTT and NCOT are somewhat similar, although the ORTT is specifically designed to capture Ops Room wide data in an integrated manner. To date it has not been proven that NCOT can capture as broad a base of data, and there have been indications that data storage capacity would be exceeded if data were to be captured for anything larger than small teams. In the ORTT, audio data are captured from each of the separate comm nets and stored independently for each net, whereas in NCOT audio data are captured on a workstation basis. The ORTT provides a capability for the placement of flags or markers of points of interest for T&E purposes (from a workstation in the control room) into the captured record, which will assist in the subsequent analysis of data. Such markers can be given a descriptor tag at the time of creation. NCOT provides no similar equivalent capability but would have to be worked around by having a member of the T&E team hit a spare key or function button on one of the workstations and the time of such action would have to be manually logged.

Conclusion: For Ops Room wide functions and team interactions, the ORTT provides a more comprehensive, robust and reliable environment for data capture. The ORTT provides better support for adding T&E flags to facilitate the analysis the captured record.

3.6.2.7 Support for data analysis

In NCOT the data record for each, separate workstation can only be played back on separate, individual workstations; synchrony of the playback of the data records from multiple workstations requires intensive manual control[5]. While this may be achievable for small teams, it would be impractical for Ops room wide playback. In the ORTT, all of the workstation data are captured in an integrated manner and the system is designed to replay selected workstations in synchrony. One limitation of the ORTT is that only three workstations at any one time can be selected for review, necessitating repeated runs through the data record in order to build the Ops room wide picture (but this would also be a practical limitation in NCOT).

In NCOT the user control over playback allows for normal play speed, fast forward to a designated time in the record and pause. After the playback record is paused/stopped it automatically goes back to the start of the entire record, with no option to continue from the pause point. In the ORTT, the record can be replayed at .5, 1x, 5x normal speed, paused and resumed and can be advanced to

[5] Or would require the use of ancillary data capture/playback equipment such as the DGx digital recorder.

previously set flags (during scenario execution). The user can also tag points in time during playback and append notes, which can be readily accessed during subsequent playbacks.

In the ORTT, unlike NCOT, audio playback is tightly synchronised with the video playback, thereby allowing all net-based communications to be heard in context of what is happening on the tactical display. The sound quality of audio playback did not suffer from the problems of noise intrusion and sometimes poor signal to noise ratios found in NCOT.

Conclusion: The ORTT provide more of the necessary controls over replay of the data record to support the extraction of information and data for T&E data analysis. The ORTT provides more accurate synchronisation of the record and audio from multiple workstations.

3.6.2.8 Logistical support - general

For NCOT, the T&E team would be required to allocate significant effort and resources in suitable scenario creation, whereas in the ORTT ready made, suitable scenarios are available.

For NCOT, additional Navy resources would be required to support each trial to act as team members. In the ORTT, this is not an issue as Navy personnel are receiving training for all team positions and data capture involves no further navy resources to act as team members.

In the ORTT, each scenario is executed with the background support of a full team of game controllers and players, who respond to (and initiate) all team communications, control game piece movement and miscellaneous scenario events. In NCOT such roles would have to be played by T&E and Navy personnel.

For the ORTT, LMC support would be required during scenario analysis only and for providing access to the control room during an exercise run (to allow the T&E team to set flags etc). For NCOT support would be required during scenario preparation, execution and analysis.

To enhance the capabilities of the NCOT replay to meet T&E analysis requirements, additional software would need to be created and the purchase of a digital data recording system would be necessary to achieve the same degree of CCS data reply as currently available in the ORTT without any software modifications.

Conclusion: Personnel costs to conduct T&E trials are significantly lower in the ORTT than NCOT. The ORTT comes ready to use without requiring additional expenditures on software and hardware. Most importantly, by taking advantage of the ongoing Navy training cycles in the ORTT, the need to continually request sometimes scarce Navy personnel resources to assist in the conduct of T&E trials using NCOT would be eliminated.

3.6.2.9 Availability/access of facility

In general, in NCOT our requests for access to date have been able to be met around the existing training schedules. For the ORTT, Navy utilisation of the facility appears to be at a high level. However, if we are only interested in the analysis of archived scenario data this can be done without disruption to ongoing training in the simulated Ops Room, since analysis is conducted in the adjacent Brief/Debrief Room. One caveat at present is that such analysis cannot be conducted at the same time as scenario execution, because there is no available software to support playback on a second unit, which currently only serves as a backup (but could be made available for playback). Without this alternate playback capability, T&E needs would have to be met in evenings, overnight and at weekends with some associated LMC costs to support the T&E team. However, the ORTT manager

believes that CFNOS could also benefit from the development of a second playback capability, as it would allow instructors to debrief some students while others use the ORTT for live training. His estimate is that it might take as little as two days programming to change the configuration to allow dual live scenario record / previous scenario playback.

To date, the Navy has been willing to accommodate the T&E requirement for T&E personnel to be present in the simulated Ops Room or control facility.

Conclusion: Existing limitations on access to the ORTT for playback would not be a significant barrier to the conduct of some T&E trials to collect pilot data in the near future. For more extensive analysis of a larger sample of scenarios, some arrangement would need to be made to contract the additional software revisions for independent playback. There is a possibility that the Navy may be willing to be a partner in such costs.

3.6.2.10 Availability of test participants

For each T&E session in NCOT, the T&E team would have to request the Navy for test participants. In the case of OROs, as was mentioned in earlier reports, this may be difficult to achieve given the sample size needs and the availability within the small population of OROs. Further, as the proof of concept in NCOT showed, the experience level and operational familiarity with personnel provided may not be optimum. On the other hand, for the ORTT, Navy personnel are continually undergoing training, with only a 4-6 week break annually (usually less). As a result, the ORTT has the potential for allowing a significant T&E database to be created with a broad cross-section of Navy training and experience levels represented.

Conclusion: The ORTT provides the potential for the collection of a more extensive and comprehensive data set that is more reliable and more generalizable to the population under study.

3.7 Summary and Recommendations

The exploratory visit to ORTT has provided an opportunity to conduct a quasi proof-of-concept analysis that goes beyond the initial assessment of the facility and parallels the recent analysis performed for NCOT. In comparing the results of our analysis for the two environments, it is clear that neither represents a 100% solution for T&E needs. For both there are some practical and logistical trade-offs that must be made. In general, for NCOT we have a higher degree of experimental control over scenario events, can conduct probes, pause the execution and control the behaviour of team members not under study. For the ORTT we have less of such control, but we achieve lower costs in trial preparation, execution and analysis, and place less demands on scarce navy SME resources. Some MOPs already considered may not be achievable in the ORTT, but opportunities for others may present themselves. Further, the sophisticated playback capabilities available in the ORTT will allow the painstaking task of extracting performance data to be conducted with a much higher level of efficiency than in NCOT (assuming that the replay software can be made to work in the latter to better support analysis than is presently the case). However, the overwhelming positive advantage of the ORTT is access to a potentially large database of performance data that is likely to be more representative of the Navy. This will result in a higher level of reliability and external validity than could ever probably be achieved with NCOT given our likely success in being able to get access to scarce, qualified Navy personnel.

Therefore, we recommend that we cease current efforts to bring NCOT to an improved level of capability to support T&E needs (i.e. supplementary digital data recording, software revisions) and

divert our efforts to conducting a pilot trial in the ORTT. The goals of this trial will be to develop methods for analysing an existing scenario record and to yield performance data on a selected subset of MOPs.

3.8 References

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4. Technical Memorandum:

ASSESSING THE IMPACT OF MULTI-SOURCE DATA FUSION ON COMMAND AND CONTROL OPERATIONS IN THE HALIFAX CLASS FRIGATE: USE OF THE OPERATIONS ROOM TEAM TRAINER (ORTT) TRAINING RECORDS TO EXTRACT QUANTITATIVE AND DIAGNOSTIC MEASURES OF PERFORMANCE

4.1 Summary

4.1.1 Background

The goal of this project was to conduct a detailed proof of concept evaluation of the ability to extract COMDAT TD relevant MOPs from archived records created during ongoing Navy training scenarios in the ORTT. It was expected that the outcome would provide a definitive direction for future T&E trials concerning the use of either the NCOT or ORTT facilities.

4.1.2 Findings

The advantages of using archived data to assess the impact of MSDF technologies include:

- No additional burden on the Navy;
- Large potential subject sample;
- Many data collection opportunities due to ongoing training;
- Large database of existing records; and
- Better data from intact teams.

However, some disadvantages do exist, including a lack of direct T&E team control over the trial, inconsistent conduct of similar or same training scenarios, and no possibility of requesting a SITREP during the actual scenario for the purposes of assessing Situation Awareness, should the need arise.

The goals of this Proof-Of-Concept (POC) trial were:

- Observe and identify potential MOPs;
- Assess the practicality of inserting tags into scenario recordings;
- Develop methods for recording and analysis of data;
- Analyse the video and audio record from ORTT software;
- Analyse the video and audio record from supplemental sources (e.g. video camera);
- Derive quantifiable MOPs;
- Determine the range of MOPs possible with this method;

- Recommend a subset of MOPs most suitable for assessing the COMDAT TD; and
- Comment on the effectiveness and efficiency of data extraction and the analysis method.

Results of the analysis

Sources for data analysis were:

- A video record of all CCS screen events
- An audio record of all net based communications
- A data file containing a time–ordered list of keystrokes from each Ops Room console
- An audio-video record of team-interactions captured by a CCTV camera and microphones during the scenario

The method of analysis consisted of three steps: the reconstruction of critical events using the CCS video record and the network communication record along a common time base; a semantic analysis of the output from the first step, and then the extraction and derivation of relevant MOPs from the first two steps. While the first two steps needed to be done using the ORTT playback capability, the last step could be done off site. It was found that the first step took roughly 36 person-hours to document 90 real-time scenario minutes. The second and third steps took 30 person-hours in total.

In general, the CCS video record was found to be easier to analyse than the communications record because the analysts could view replay from three Ops Room consoles at once, whereas only one audio net could be played back at a time. Further, the screen data was less transient than the audio, which made it easier to assess the critical information from relevant team workstations at one time. Much of the time in analysis was taken up with the extraction of the sequencing of communication messages, the identification of sources and recipients and the piecemeal reconstruction of the information flow among the team.

The data recording of all keystrokes captured from each CCS console was found to take significantly more effort to analyse compared to the three steps described above and was not pursued at length. It was established that there could also be security implications associated with removing the raw keystroke data from the ORTT for more detailed analysis off-site.

The separate audio and video tape records of inter-team interactions (not CCS or comm. based) were only needed to be consulted if other analyses were ambiguous, or data were missing or corroboration was required.

The appropriate COMDAT TD relevant MOPs derived from this POC were a subset of the MOPs based upon the original ORO CTA and first examined in NCOT. The table below lists the number of MOPs associated with each functional operational area and specific COMDAT relevant tasks. In total, 52 MOPs were derived.

ORO MOPs for air events	27
ORO MOPs for sub-surface events	7
ORO MOPs for surface events	4
Additional team MOPs	14
MOPs specific to MSDF	12

Table 4.1: Number of MOPs derived for each operational area

4.1.3 Conclusions

In general, all of the trial goals were achieved satisfactorily

It was concluded that in comparison with NCOT, ORTT is considered a better environment from which to collect COMDAT TD relevant MOP data. MOPs for a range of critical tasks in the detect to resolve process could be extracted from the data record for air, surface and sub-surface events.

Five recommendations resulted from this study:

- A full data collection trial should be conducted using ORTT training records to generate the baseline comparative MOP data set (using the MOPs short-listed in this report) for MSDF relevant contexts and tasks.
- A standalone debrief facility should be developed that can be used while ORTT is running to permit more flexible scheduling of data analysis and more efficient data extraction.
- Assuming, the MSDF TD is to be implemented in the **CSTC**, a pilot trial in this facility should be conducted to fully evaluate the ability to collect the MOPs identified for the evaluation of the impact of the MSDF technology.
- To facilitate the collection of data in the CSTC (should the need arise), acquire, or make available, supplementary digital data capture, such as the DGx system.
- Conduct an evaluation of the capability of the COMDAT MSDF prototype workstation and software to collect MOP data for test and evaluation purposes.

4.2 Background

This report represents part of a continuing contribution to the understanding and measurement of processes that support Command and Control (C2) in the Operations Room (Ops Room) of the Halifax Class frigate. This program of work has been contracted to HumanSystems Incorporated (HSI®) by DRDC-Toronto and has the current goal of developing reliable, valid and representative Measures of Performance (MOPs) of Ops Room processes that can be realistically collected in a comprehensive Test and Evaluation (T&E) program.

The work has its historical roots in a review and analysis performed by HSI® into the wide range of measures that have been used to assess C2 and other military processes. This review resulted in recommendations for how formal evaluation may be conducted for generic military C2 contexts (Matthews, Webb and McCann, 1997). Subsequently, the focus for analysis has been the Ops Room of the Halifax Class frigate, where a number of related studies have been conducted in recent years. The most relevant to the current report are a Cognitive Task Analysis (CTA) of the Ops Room Officer (ORO) (Matthews, Webb and Bryant, 1999) and subsequent validation (Matthews and Webb, 2000), and the development of measures and methods to collect MOP data to assess Ops Room C2 performance, with a focus on the ORO (Matthews, Webb & Keeble, 2001).

The current work focus is in direct support of the COMDAT Technology Demonstration Project (TDP). The *objective is to develop MOPs that will be useful for quantitatively evaluating the impact of new technologies resulting from this program on human-system operational performance in the Ops Room.* Further, the collection of baseline MOPs on a variety of Ops Room critical tasks will provide an important point of reference for developing and evaluating a variety of future Navy initiatives. These include Ops Room redesign, integration of new systems, changes to training and new training technologies and the analysis and development of tactics and Ops Room procedures.

In leading up to the present work a number of preliminary studies have been conducted as part of the overall T&E Plan, which is described in Matthews, Webb and Keeble (2001). Initially, as suggested in this plan, HSI® conducted a Proof of Concept (POC) trial in the Naval Combat Operator Trainer (NCOT) with a view to assessing its suitability to support T&E for the collection of MOPs for a small Ops Room Anti-Air Warfare (AAW) team. Limitations of the NCOT facility revealed as a result of the POC (Matthews, Webb, Keeble, 2002) and the potential difficulty in obtaining the quantity and range of Navy Subject Matter Experts (SMEs) to support T&E in this environment have suggested a re-focussing of future data collection efforts on the Operations Room Team Trainer ORTT facility.

Initially, the T&E plan had considered adapting the ORTT to meet the specific requirements for conducting T&E trials, whereby the ORTT would be used exclusively to collect T&E data with test participants specifically recruited for each trial. However, difficulty in booking time at the facility for T & E purposes, as well as the overhead that would be required of the Navy for both running the ORTT and providing test participants just for T&E purposes, suggested consideration of another strategy for MOP data collection in the ORTT. Since the ORTT is continuously used for training full Ops Room teams for much of the year, with a large range of trainee levels, the possibility was considered of extracting MOP data captured from such training exercises using the built-in ORTT data recording and playback.

Such an approach has several merits.

- No additional burden on the Navy for T&E trials with support personnel and trial participants.

- Data collected from a wide range of Navy personnel, thereby improving reliability and generalisability of MOP data collected.
- Ongoing use of the ORTT for training provides many opportunities for collecting T&E data.
- A large ORTT database of exercise records representing Navy personnel operating under quasi-operational conditions from which performance data can be extracted.
- Detailed data from T&E assessments using intact teams could provide important insights to the Navy about team performance issues not readily ascertained when the team is assessed during training.

Using pre-recorded scenario data from the ORTT was also seen to have some disadvantages.

- No direct T&E control over the trial, for example to vary circumstances in a systematic manner or to inject situational awareness "probes" into the information stream.
- Scenarios could not be repeated precisely because training exercise controllers introduce events depending upon how the team under observation is performing.
- T&E could not request a "SITREP" to assess situational awareness of any team member at a particular point in time.

Despite such limitations, on balance, scenarios recorded in the ORTT for Navy training are a valuable potential source for the collection of data for MOPs. Accordingly, a feasibility assessment was conducted at ORTT and a technical memorandum delivered to the Scientific Authority (Matthews, Keeble and Bruyn, 2002). The conclusions from that assessment are summarised below.

Comparing the results of the POC for the NCOT and ORTT environments, neither represents a 100% solution for T&E needs. For both there are practical and logistical trade-offs that must be made.

- For NCOT, in general, there is a higher degree of experimental control over scenario events, an ability to conduct probes, pause the execution and control the behaviour of team members not under study (assuming the ORO is the point of focus).
- For ORTT there is less control, but lower costs are associated with trial preparation, execution and analysis, and fewer demands are placed on scarce navy SME resources. While some MOPs already considered as part of the T&E plan may not be achievable in the ORTT, the more sophisticated playback capabilities in ORTT allow greater efficiency for the painstaking task of extracting performance data than NCOT. This is so even if NCOT replay software can be improved.
- The biggest single advantage of the ORTT is the large database of exercise records representing Navy personnel operating under quasi-operational conditions from which performance data can be extracted. This will result in a higher level of reliability and external validity than could ever probably be achieved with NCOT, even if given unlimited access to scarce, qualified Navy personnel for trials in NCOT.
- Finally, in ORTT, realistic workload levels are much easier to achieve, especially for the ORO and other team leaders, since a full Ops team environment can be provided for the team leader(s) to have something to do other than merely monitor their screens.

Therefore, on the basis of the two POC trials, we recommended to the Scientific Authority that we cease ongoing efforts to bring NCOT to an improved level of capability to support T&E needs (i.e.

supplementary digital data recording, software revisions). Instead, we recommended diverting our efforts to conducting a pilot trial in the ORTT. The goals of this trial being to develop methods for analysing an existing scenario record and to collect sample performance data on a selected subset of MOPs.

The Scientific Authority has concurred with this recommendation and agreed to conduct a small pilot trial in the ORTT to demonstrate the type of MOP data that could be extracted from the scenario record. A secondary goal was to develop and assess the specific methodologies and procedures that would be required for the data extraction. The balance of this report presents the outcome of this pilot trial.

4.3 Goals of the ORTT trial

Before outlining the specific goals of the trial, we will briefly review the overarching goals of the T&E program. Two types of goals are associated with this ongoing program, one more science based, the other more practical to the Navy community, but both are related and have common elements.

The science-based goals reflect an ongoing analysis, conceptualisation and measurement of processes in Command and Control. To this end, we have identified key processes and functions performed by the ORO and have suggested a research and measurement plan to further the goal. The more general goals of this program are to look at decision support tools for the Ops Room for a wide range of functions that go beyond picture compilation and include engagement and response functions and process monitoring.

For COMDAT, the more practical goal is to evaluate the operational impact of MSDF technology on critical Ops Room tasks. This technology impacts most directly on the picture compilation component of the overall detect-to-engage process[6]. We believe that the technology can best be assessed by measuring key processes in the **detect-to-resolve[7] cycle** using appropriate MOPs. These MOPs are expressed in quantitative terms such as percent accuracy, percent errors, time to perform certain tasks, total time spent in associated communications and percent communication errors.

As a concrete example, let us consider the team task of identifying an unknown air contact. By collecting baseline performance data it might be established that the average time from the first appearance of an unknown contact on the CCS to its identification (for example) is 7.5 sec with an accuracy rate of 98% and five associated communications totalling 40 seconds. These baseline numbers enable evaluation of performance on similar tasks with the benefit of MSDF technology and permit the Navy to draw informed, data-based conclusions as to the operational impact of the proposed technology.

For some Ops Room functions performance cannot be reflected by observable tasks that can be timed or assessed for accuracy (e.g. wide area picture integration, tactical assessment). For such cases, we propose the use of subject matter expert (SME) assessment using valid and reliable

[6] This is our best assessment of how MSDF technology will impact on Ops Room tasks based upon our understanding of the current progress of the TDP. Should MSDF have impacts on other tasks beyond picture compilation and the detect-to-resolve cycle, then a more suitable subset of MOPs will need to be selected from the complete set already identified.

[7] By resolve we mean the overt act of assigning an ID (Assume Friend, Friend, Suspect, Hostile) to a contact. This should not be confused with the formal "resolve" process, which the SWC initiates with “All positions, resolve track XXXX”.

behaviourally anchored rating scales to compare performance of individuals and teams with and without the benefit of MSDF technology.

For the purpose of the present trial with its COMDAT MSDF focus, we have concentrated on the detect-to- resolve process and surface, air and sub-surface picture building. These detect-to-resolve processes include tasks such as contact detection and identification and threat assessment that fit under the general CTA ORO function of "Manage Ship Surveillance". However, as indicated above, other functions and MOPs relating to threat engagement and the ORO's monitoring of Ops Room tasks have been previously identified as candidates for improved decision support though probably outside the influence of MSDF. These could become the focus of data collection using the methods outlined below, should future needs arise. Thus, a full range of potential MOPs to support these longer-term goals has also been identified in the pilot trial.

The specific goals of the ORTT POC trial were as follows:

- Observe a training scenario in action and note areas of interest to the T&E team for potential MOP extraction.
- Assess the practicality of inserting T&E "tags" into the scenario record during scenario execution to assist in subsequent MOP analysis.
- Develop a methodology for analysis and recording the captured data.
- Analyse the digital video and audio record (using ORTT Debrief software) to build the ongoing team picture and communications for selected events.
- Analyse the supplementary video and audio record (using a standard VCR) to build the ongoing team picture and communications for selected events.
- Derive quantifiable MOPs from the previous analyses.
- Determine range of potential MOPs that could be assessed using the methodology
- Make recommendations for the specific subset of MOPs that would be most suitable for assessing the impact of MSDF technology in future trials
- Comment upon the effectiveness and efficiency of the data extraction and analysis methodology and its implications for logistical and other support in future trials.

4.4 Method

The trial was conducted during an existing ORTT training exercise in which a full ship's team is being assessed. The ORTT consists of two HFX Ops room simulators (Cubicles 1 and 2) each with an associated bridge simulator, thereby permitting simulator training exercises involving two complete ships Ops room plus bridge teams. In this case, one team was being evaluated, while the other team was not, and acted under the directions of exercise control to assist with the evaluation.

4.4.1 Participants

The personnel in the ORTT trainer during the pilot study comprised two Ops Room teams, one in each cubicle of the trainer. The team in cubicle 1, which we will refer to as Team 1, was a fully functioning Ops Room team from a Halifax class ship which had recently returned from operational deployment, and was going through work-ups. This team had been in the ORTT trainer

for the entire week (i.e. four days prior to the pilot study) and was being evaluated on the day of the pilot study. In the four days prior to the pilot study, the team had worked through a variety of basic, predefined scenarios, which enabled the team to practice their teamwork skills prior to evaluation on the final day. The team in cubicle 2 (from the same ship), which we will refer to as Team 2, represented another fully functioning Ops Room team but was not being evaluated at the time of the pilot study. We limited our data collection to Team 1, on the assumption that because they were being evaluated, the team member's performance would be more representative of typical Ops Room team performance on an operational mission.

4.4.2 General Scenario

This scenario description is for illustration only to provide a context for the events that have been recorded. It is not intended to represent all aspects of the mission scenario that would be detailed in the OPGEN message.

A Canadian Task group is operating in open ocean blue water. It has the standard composition of:

- One replenishment ship (Preserver)
- One Iroquois class destroyer (Algonquin)
- Three Halifax class frigates (Halifax, Vancouver, Regina)
- Four embarked Sea King helicopters (2 active dipping CH 124A, 2 passive CH 124B)
- One MPA (British Nimrod)

There is a known friendly submarine in the vicinity, but there appears to be no other friendly task group. Two friendly Combat Air Patrol (CAP) will join the TG. There are high level, commercial air lanes and surface commercial vessels are transiting in the vicinity.

Command responsibilities are as follows:

- Commander of the Task Group (CTG): Embarked in Algonquin
- Anti-Air Warfare Commander (AAWC): Algonquin
- Anti-Submarine Warfare Commander (ASWC): CTG embarked in Algonquin
- Anti-Surface Warfare Commander (ASuWC): CTG embarked in Algonquin

Sector assignments and the disposition of the TG are shown in Figure 3.1.

Without our knowing the full ROE, we have assumed that all enemy units are to be regarded as hostile and to be engaged and destroyed. The enemy is known to have submarines in the area and there are several enemy surface groups in the vicinity. The Task Group also has its own MPA assets and the capability to pass over-the-horizon-targeting information for co-ordinated engagements.

4.4.2.1 Terminology

Throughout the report to avoid confusion, we will distinguish between the Halifax Anti Submarine Warfare Director (ASWD) and The TG Anti Submarine Warfare Commander (ASWC), which differs from the terminology that has been used in previous reports. The acronym AS will refer to the TG Anti Surface Warfare Commander (Also ASuWC) and AX as the TG Anti Submarine Warfare Commander.

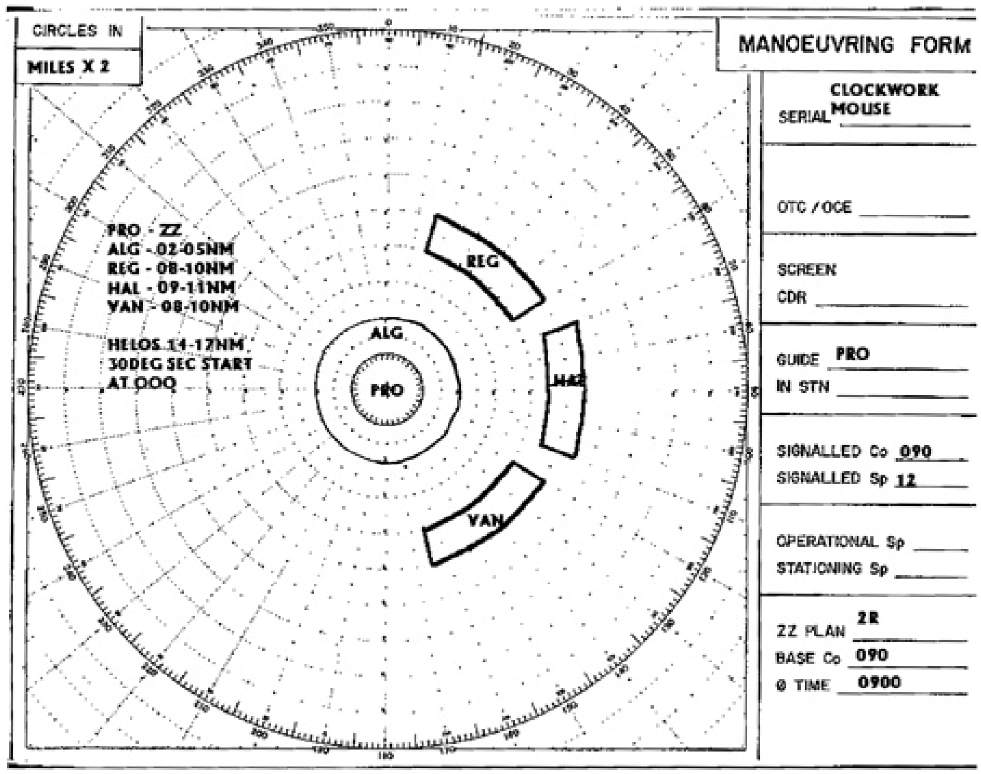

Figure 4.1: sector assignments and disposition of the Task Group

4.4.3 Equipment

Data collection took place in the briefing room of the ORTT trainer. The briefing room is used both for briefing Ops Room teams during their training sessions in ORTT, and for students and staff to monitor the Ops Room performance during a scenario run. Two projection screens and a 47” CRT monitor are located at the front of the briefing room and, along with two speakers mounted on the wall, allow real-time audio and video monitoring of a scenario run. At the back of the briefing room, there is a workstation that includes:

- A Pentium I PC running ORTT "Debrief" software that was capable of reproducing exactly the Command and Control System (CCS) display for any team position.
- Four 16” monitors connected to the PC: three monitors could display different CCS screens, while the fourth was used to interact with the Debrief software to control the data playback.
- A desktop speaker for replay of audio communication.
- Two video cassette recorders that will play, in real-time, audio/video recordings from a video camera and microphone in cubicle 1 during scenario playback.

CCS displays could be selected for each of the following Ops Room Team members: CO, ORO, SWC, ASWD, ARRO (formerly RT1), ASPO (formerly RT2), TS, SAC, EWS.

Audio communications

The generic network of communication links for the Halifax class ships in the context of this scenario comprises the following external and internal networks:

External:

- TG Command: CO, ORO
- *AAW Coord*: SWC, ARRO, EWS
- *ASW Coord*: ASWC, ASPO, SAC
- TG Reporting: TS

Internal:

- *C&C*: CO, ORO, OOW, TS
- *AWW Coord*: SWC, ARRO, EWS, FCS
- *ASW Coord*: ASWD, ASPO, SAC, SCS

These are shown organised by Ops Room personnel position in the following table.

Position	Internal (Primary)	Internal (Secondary)	External (Primary)	External (Secondary)
CO	C&C	AWW/ASW	TG Command	AAW/ASW
ORO	C&C	AWW/ASW	TG Command	AAW/ASW
SWC	AWW	C&C	AAW Coord	TG Reporting
ASWD	ASW	C&C	ASW Coord	
TS	C&C		TG Reporting	
ARRO	AWW		AAW Coord	
ASPO	ASW	C&C	ASW Coord	TG Reporting
EWS	AWW		AAW Coord	
SCS	Sonar	ASW	ASW Coord	
FCS	AWW			
SAC	ASW	C&C	ASW Coord	TG Reporting
OOW	C&C	AWW/ASW	ASW/AAW	TG Command/TG Reporting

Table 4.2: Internal and external communication networks organized by Ops Room position

For the CO and ORO, whether they are on AWW or ASW internal or AAW/ASW external is threat dependent. The same applies to the OOW, but the OOW can also monitor more circuits at once because he can put several SHINCOMS on a speaker. The OOW is always on C&C, with usually two external circuits monitored on speaker. The OOW will not speak on these external circuits, only listen. The reason the ASPO may be on C&C and TG Reporting as secondary circuits is that when there is no ASW threat he will help with surface picture compilation, which happens on TG Reporting. The configuration identified for the SAC is in an ASW threat environment; if the helo or MPA he is controlling is on a surface search mission, he will probably be in the secondary

configuration. The FCS is not on an external net. The SCS is normally on two internal nets, going onto the external only occasionally. Other than these cases, everyone usually is monitoring one internal and one external circuit simultaneously.

The ORTT Debrief facility only permits the playback of one of these communication networks at any time. For the purposes of the pilot study, wall-mounted speakers or PC speakers were used to monitor the playback of the audio communications.

The HSI® T & E team comprised the project director (M. L. Matthews), a consultant (L. Bruyn) a Navy SME (R. Keeble) and was assisted by the ORTT manager. The team used a laptop computer to record data extracted from the scenario playback and also collected printouts from a printer located in the control room to capture screens (from any Ops Room CCS) at various points during scenario playback to assist in understanding and analysing the tactical picture.

Keystroke data

A further source of scenario data produced by the Debrief software is a time-ordered sequence of keystrokes captured from each workstation. This record may be displayed on one of the Debrief displays but there is no control over the format of the output. Thus, it is not possible to display just the keystrokes only from one position, or selected keystrokes, or for a specified time interval. This data record is not only considered to be confidential but also cannot be exported to other file formats to aid in analysis. Other than reviewing this data record for its potential to yield MOPs, no attempt was made to analyse the keystroke record.

4.4.4 Procedure

We were able to observe approximately three hours of training with an intact ship's Ops Room Team. However, the scenario observed was somewhat different from the regular training scenario in that it required the ship to pursue a possible hostile contact without the usual context of a TG. This contrasts with a typical training scenario in which the ship under training responds to a series of air, surface and sub-surface contacts and threats in a typical TG format. The more typical training scenario was considered to be more representative and appropriate for the analysis of MOPs and extraction of data. Thus, the scenario under observation did not allow us to note specific scenario events that would be the focus of MOP analysis. Instead, we used a record of a more typical TG scenario record from the previous day, which meant that there was some additional analysis overhead in first reviewing the record for areas of interest for analysis.

The scenario segment was about 120 minutes in duration with approximately 50 minutes anti-air warfare, 30 minutes anti-submarine warfare and 30 minutes anti-surface warfare. As previously noted, we focused on the performance of Team 1 since they were being evaluated. In order to capture the data, we reviewed approximately 75 minutes of scenario playback, first at a higher level in order to get a general perspective of the events within the scenario segment. This allowed us to select the events for which we wanted to gather more detailed information. Within this 75-minute scenario segment, we then decided to focus on, and attempt to extract, data for one air, one surface and one subsurface series of contacts. The data extraction procedure is described in the following section.

During playback we were able to select and observe the CCS display for three different Ops Room team members and simultaneously monitor one communications network. We also had the ability to pause the replay and change the ORTT team position selected on any CCS display and change the communications network at any point during scenario playback.

The CCS displays selected depended on the specific scenario event and the key team members for that event, as follows:

- Air contacts: ORO, SWC and ARRO displays (supplemented by the CANEWS operators or SAC, when necessary)
- Surface contacts: ORO, SWC and TrackSup
- Sub-surface: ORO, ASWD and ASPO

Similarly, the communications network selected for monitoring was dependent on the specific scenario event. For example, if the scenario event involved significant communication between ships in the TG, the TG Command network would be monitored. On the other hand, if the scenario event involved communications about a missile fire by ownship, the internal AWW Coord network would be monitored.

4.4.4.1 Data Extraction

For the purpose of the pilot study, it was decided that relevant data would be extracted from the scenario record for scenario segments that focussed on air, surface and subsurface picture building. Scenario playback, and therefore data extraction, for each event started just prior to initial registration of the air, surface and subsurface contact on the CCS. Scenario playback and data extraction for each scenario event ended at the point of resolution or at the end of threat engagement for the air, surface and subsurface contact. In total, it took approximately 12 hours of initial data extraction by 3 persons to capture 75 minutes of the scenario.

As previously noted, the specific CCS displays and communications network being monitored were dependent on the specific scenario events and hence varied throughout the data extraction process. In order to extract sufficient data for each contact from detection to resolution, it was necessary to repeatedly pause, analyse and note, then rewind and playback each scenario event or contact. This iterative analysis required observing different CCS displays or monitoring a different communications network, in order to extract all of the pertinent information for an event. During this process co-ordination and registration between the different CCS displays was maintained.

The data extracted from video (CCS display) and audio playback of scenario events was logged directly into a spreadsheet by the T & E team. This included:

- **Network communications** including the specific network over which the communication occurred (e.g. C & C, TG Command), the identity of the person sending the communication, the identity of the person receiving the communication and the content of the communication.
- **Local picture information**, such as range scale, at critical points in the scenario playback (printouts of the CCS display provided this information as well).
- **Hooked tracks** at critical points in the scenario playback.
- **Time of occurrence** for each network communication, local picture change, keystroke, or significant event logged.
- **Additional comments** noted by the experimenter for future reference. For example, an Ops Room Team member might have been on a different network channel and therefore missed an attempted communication from another Ops Room Team member. This represents important information that would not be captured by the above data extraction methods.

The printouts of a specific operator's CCS display at critical points in the scenario playback provided more detailed local picture information and could be used to validate local picture information logged in the spreadsheet by the T & E team.

Although our objective was to focus on performance, specifically actions and communications, of the ORO, it was evident that actions and communications of other ownship Ops Room team members and other TG members either directly or indirectly affect the ORO's performance. Further, for the purpose of evaluating the potential impact of MSDF technology, it was necessary to also analyse tasks of other teams members in the picture building and contact/threat identification process as well as associated communications. Therefore the decision was made to extract data for all relevant ownship Ops Room Team members and TG members for each scenario event. This then allows us to consider the context surrounding the ORO's performance. For example, the time it takes the ORO to interrogate a contact may be affected by the fact that the SWC tried to provide information to the ORO on a network channel that the ORO is not listening to. This could only be determined by logging the network communications of the SWC rather than those of the ORO alone, and analysing overall information exchange patterns among team members and their associated timeliness and errors.

4.5 Results

The data record collected in the manner described above comprised an Excel spreadsheet file. This was reviewed by the HSI® team and LMC ORTT support personnel and deemed not to contain any confidential data.

For the purpose of this report, three edited and selected segments of the data record are included in Annex C, each corresponding to a separate series of events in air, surface and sub-surface. The full record has been provided to the Scientific Authority separately from the report in electronic format as an Excel spreadsheet.

The results will be presented as follows. First we will provide an overview and detailed narrative of each event series (air, sub-surface, surface) with reference to the data record. These are described in the chronological order in which they occurred in the scenario. Second, we will provide concrete examples of MOP data extracted from each event series. Third, we will comment upon other potential MOPs that might be extracted. Finally, we will review the preliminary MOP list outlined in previous reports and provide a summary of the potential and suitability of the ORTT to facilitate data collection and extraction relevant to each MOP.

It will become apparent in subsequent sections that the full communication record was not analysed in as much detail as the record of CCS events captured in the data record. For matters of expediency and limited time available we concentrated on the CCS record. This should not be taken to mean that we believe that the communication record is neither worth analysing nor amenable to analysis. We believe that the total time spent in communications, communication errors and communication latencies all represent important MOPs that may reflect the impact of MSDF technology. Indeed, in some instances communication measures may provide the appropriate level of diagnosis and analysis concerning how the technology impacts on the detect-to-resolve cycle.

4.5.1 Air event series: description and overview

Although the following narrative concentrates largely on air warfare events, other relevant information from other warfare domains will be interleaved as they relate to the ORO's picture building, tactical planning and situation awareness. In order to understand the relationship among the various main events and actions a GANTT style chart (Figure 2) has been prepared. This shows the time of onset and duration of each of the new, main, contact events, significant responses from the Ops Room team, the ORO's picture (as exemplified by his selected range scale) and the ORO's communications. For clarity, existing contacts on the CCS plot at the start of the scenario series have not been included.

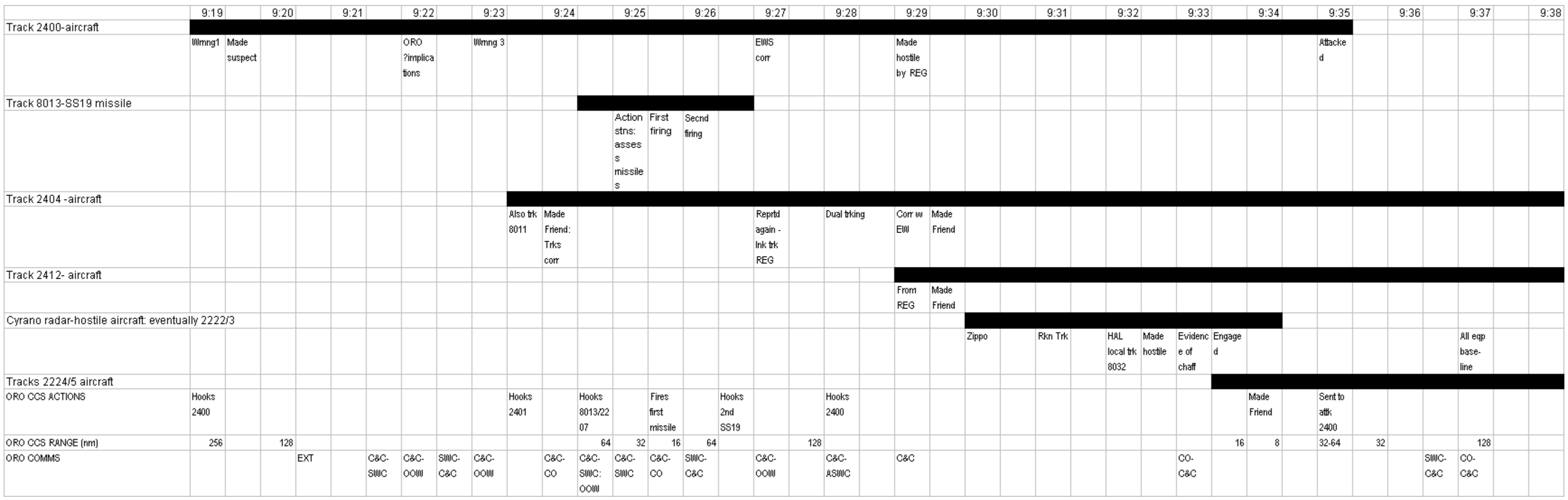

Figure 4.2: Gantt chart showing main events and actions for air contacts

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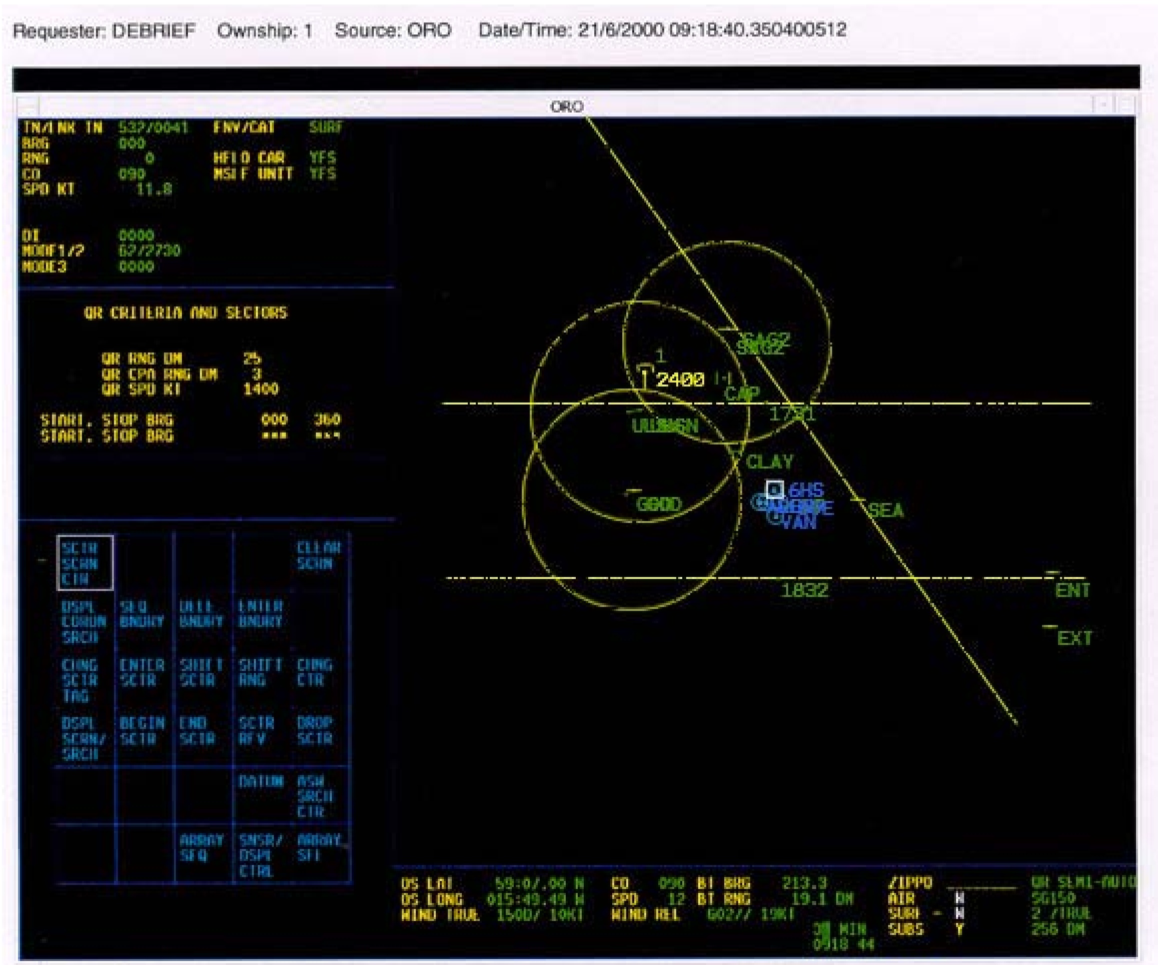

Figure 4.3: ORO CCS Display at Scenario Start

The segment for analysis starts soon after the scenario has commenced. At the start of the segment, the ORO CCS display is centred upon the area of operations at a range of 256 nm (see Figure 3). High level air lanes (solid, straight yellow lines) and Areas of Probability AOPs (yellow circles) associated with known submarines (one of which is believed to be an OSCAR type, based on intelligence) and SAGs are shown in yellow. The ORO has a surface consort hooked (box around contact) and there are at least one commercial (green track number 1632) aircraft in the air lanes. This suggests that at present the ORO is building/maintaining the *global* picture. The Task Group has two sub-surface AOPs close by, based on time late locating information provided by intelligence. Then:

- At 9:18.44, a new, unassessed air track (2400) appears NW of the TG, which the ORO immediately hooks.
- The SWC who is ranged at 128nm, orders resolve on track 2400.
- Within 10 seconds, the ARRO reports on the AWW net no IFF and 4 seconds later CANEWS reports no EW.

- Two seconds later the track is made suspect the SWC orders that "warning #1" be issued[8].
- The ship then receives a brief SITREP from the AAWC in ALG.
- Five seconds later, the ORO hooks track 2400 and ranges down to 128 nm, which would indicate shifting to the local picture and paying attention to this potential threat.
- At the same time the ORO announces that he is going external from the C&C net.
- While he is external, the SWC provides a SITREP: a general assessment as well as comments on track 2400.
- There is no communication to indicate that the ORO is "back from external", so we might assume that he misses this SITREP from the SWC.
- At 9:21.40, three minutes later, the ORO asks the SWC if there are any surface contacts that 2400 may be passing targeting information to.

This indicates that the ORO is thinking about the tactical implications of 2400 and integrating the air and surface pictures. Of interest is the fact that the SWC misunderstands this question and agrees with the ORO that 2400 is an MPA. This suggests that the SWC is thinking more locally about track 2400 and not the surface picture.

- Five seconds later, the ORO's attention is shifted to the sub-surface picture by a routine SITREP from the ASWD and the ORO prompts with a request for more information about AOPs.

Something in the SITREP causes the ORO to order a second torpedo loaded onto one of the helos. In fact, a few seconds later a sub-surface track (2403) appears on LINK from REG. Thus, in the space of 20 seconds, the ORO has shifted from the air/surface picture to the sub-surface picture and shows evidence of planning ahead.

- Further evidence for this is found at 9:22:19 when the ORO hooks the AOP associated with a submarine.
- Five seconds later, the ORO's attention is drawn back to the air picture, when the SWC announces that "warning 3" is to be issued to track 2400.

Remember that only "warning 1" had been previously issued. We were not able to find anything in the communication record between the SWC and ORO concerning "warning 2", so there seems to be some communication failure here which would critically impact upon the ORO's appreciation of the air picture and the urgency of the potential threat from 2400.

- At 9:24.30, further evidence of this confusion is shown when the SWC informs the ORO that they have been ordered to issue "warning **2**" to 2400![9]
- At 9:23:04 a new air track (2404) by link from REG and a few seconds later HAL generates a local track (8011) - within one minute these two tracks are correlated by the ARRO.

This has happened without any indication of ORO interest (which would be expected given that the track is commercial air), who is now off the C&C net and talking with the ASWC. The ORO

[8] The direction for this would normally have come from the AAWC, or it may have been directed in the OPTASK AAW to automatically issue warning 1. Whichever the case, this issue was not considered sufficiently important for present purposes for us to spend time tracking down this information.

[9] The order to issue this warning would come from the AAWC in ALG.

appears to be in the process of sub-surface picture building and talking to the CO at this time about the position of HAL in relation to the sub bullpen.

- At 9:24:24 a new air track (8013-missile- 30 nm NE) appears which is hooked within 3 seconds by the ORO who then receives the message from the SWC about warning 2 to track 2400. The track is immediately identified as a missile because of speed.

The ORO directs the SWC's attention to the incoming missile who immediately initiates a resolve on this track. The ORO then contacts the OOW concerning the location of the incoming missiles and a few seconds later the ship is brought to Action Stations.

- Ten seconds later the SWC reports that the tracks are assessed as missiles, based upon speed and ESM, and three seconds later the ORO agrees with this assessment and the ORO's array selection shows that he is ready to fire against the incoming missile.
- Forty seconds later, the SWC hits the fire button to engage the missile, but unknowingly is on the wrong page of his input array.[10] Although there is a call "missile away" on one of the nets, unbeknown to the SWC it is the ORO who has fired the missile.

Apparently, the ORO was able to monitor the SWC's firing, recognise the error and step in to rectify the situation within the space of 15 seconds. The elapsed time from the SWC initiating the firing and the missiles getting away is 33 seconds. Ten seconds after the first missile launching, the SWC successfully gets away the second missile.

Of interest, just before the ORO is about to initiate the launch of the first missile, the ASWD asks to give a SITREP - which the ORO unsurprisingly ignores. Although the ASWD will have heard the action alarm and pipe, he appears to be unaware that this is an inopportune moment to be delivering a SITREP.

- At 9:27:00, following the engagement, the ORO directs the OOW to resume patrolling the sector and ranges out to 128 nm to resume building the larger picture.
- During this time of the missile attack the assessment of Track 2400 has been continuing and at 9:27.08 EWS reports EW racket which correlates with Track 2400 and identifies contact as "Mainstay.
- Track 2404 is again reported by LINK from REG and for a while there is some "dual tracking"[11] as HAL is holding a local track on it.
- At 9:29:30, after about 30 seconds of dual tracking, the ARRO correlates the two tracks and the contact is made Assumed Friend.

During this period, there is no evidence that the ORO has been following the progress of 2400 and 2404. Instead, he appears to be still concerned about building the ASW picture.

- At 9:27:50 the ORO has a discussion with the ASWD to refine the AOP for the OSCAR sub, based upon the assessment that it was responsible for the SS19 missile attack. Within 10 seconds he then switches back to the air picture and hooks track 2400.
- At 9:28:50, one minute later, a new air track (2412) is generated by REG.

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[10] We were able to determine this by comparing the array selection of the ORO and SWC at the point of firing the missiles.

[11] By dual tracking in this instance we mean that there two tracks have been generated for probably the same target from different sensor systems or platforms

- Fifteen seconds later 2400 is made hostile by REG and the ORO orders on the C&C net that 2400 be made hostile and is assessed as "Mainstay" (a known, potentially hostile, air platform)[12].
- At 9:29.20 a "zippo" call is made by the EWS on a specific EW racket and a recon track is put in on the appropriate bearing. The zippo call reflects a positive identification of an aircraft radar that is associated with an air to surface missile.
- Sixteen seconds later, HAL's SG150 generates local air tracks (8032 and 8033) which are released to LINK as hostiles 2222 and 2223. Of interest, during this important change in threat status, the ORO has had no direct role in the process but has been monitoring the associated air picture.
- Within 30 seconds, the EWS recommends that the tracks are aircraft not missiles based on course and speed alterations - the SWC agrees.
- Eighteen seconds later, evidence is seen on the SG 150 radar of chaff released in the vicinity of these tracks; five seconds later the ORO receives an order from the CO to change the missile firing parameters from a salvo engagement to a single shot engagement.
- After the firing of the missiles the ORO ranges down to 16nm and then 8nm to follow the engagement.

Of interest, the ASWD also follows this engagement down to the same range, rather than concentrating on the AOP for which he has primary responsibility. The total time from the initial contact of the two unknown contacts to the decision as to how many Sea Sparrows to use against the contacts was one minute.

- Towards the end of this engagement, two new air tracks (2224/5) have appeared and been interrogated on IFF by the ASPO (the ARRO was presumably following the ongoing engagement) who makes them friendly based on Mode 4.
- Thirty seconds later the ARRO ranges out and picks up these tracks. There appears to be no discussion on the HAL nets among the team about these contacts. At 9:35.20 the AAWC advises HAL that he is sending the CAP (2224/5) to attack 2400.
- At 9:36 the SWC provided a SITREP to the ORO, recommending return of all equipment to baseline and updates status of missile inventory.

4.5.1.1 Analysis of ORO's air contact activities

This sequence of events underlines the findings derived from the CTA of the ORO (Matthews, Webb & Bryant, 1999). Namely, that the ORO is constantly switching between many pictures and levels of the tactical environment as he simultaneously monitors and guides all Ops Room processes, seeks and integrates data to build an integrated view of the combined tactical picture, and plans ahead.

It would appear that the ORO's highest priority concerns sub-surface threats, as there appears to be ongoing uncertainty concerning their specific location, proximity and hence danger to the TG. This priority is evidenced by his several conversations with other team members concerning the sub-surface picture and his plans for launching a helo to improve this picture and possibly deal

[12] There is some ambiguity in the interpretation of this event which may not be resolved without further delving into the communication record. Earlier HAL's EWS had reported a Mainstay racket that correlated with 2400. HAL should have made 2400 Hostile based on that, but apparently didn't. If REG is the one that made 2400 hostile, then HAL's SWC would not order on C&C to make 2400 hostile as it already would be. Perhaps instead he reported on C&C that 2400 was hostile.

with any threats. Note that the ORO was previously ordered by CTG to re-arm/launch his helo. Thus, the ORO is reflecting the high priority that the ASWC has regarding the ASW threat, and is weighing this concern against the immediate air threat. The ORO also shows clear evidence of integrating the tactical pictures across warfare domains in his concern over the role that contact 2400 (a potentially hostile MPA) may be playing in passing targeting information to enemy submarines or SAGs.

The ORO's overall concern for the sub-surface picture is punctuated by shifts in focus to monitor short-term, urgent air threats. In these cases, his role tends to be that of close supervision and management of processes rather than being directly involved in the detect-to-resolve-to-engage activities. His awareness of an error in these processes is evidenced by his immediate taking over of the firing of the first missile against the incoming SS-19, when the SWC failed to initiate the firing.

4.5.1.2 MOPs

For clarity, we divide the MOPs into two categories:

- MOPs centred on the ORO and derived from the CTA and subsequent analyses, and
- MOPs oriented towards COMDAT MSDF and the impact of that technology on the D2R process.

Because of the limited time available for analysis of all of the MOP data that was potentially available, illustrative examples of as many MOPs as possible that could be readily extracted are provided.

For consistency, task and MOP numbers refer to MOP tables in prior reports.

We define key MOP terms as follows:

Accuracy: usually percent correct - number of correct items/number of opportunities (example: ten hostile a/c appear during scenario- team correctly identifies 8 - hence accuracy is 80%).

Response time: usually the time from the onset of an event as defined by a recognised trigger point for the team. (For example, this could be the appearance of a CCS contact or a message on the net) until a recognisable action is taken that terminates the event (a contact is made suspect, friend or hostile). (Example: time from detection of new underwater sonar contact to the call "Poss sub 1" is 25 seconds).

Communication: typical measures include the total number and/or time spent in comms around a specific event. For example, eight queries among AAW to identify a contact; total time in queries 40 seconds. Other measures include the rate of occurrence of errors (number of error messages expressed as a percentage of the total number of messages) and the rate of requests for repeated messages (number of requests expressed as a percentage of the total number of messages).

ORO centred MOPs

DETAILED MEASURES	EXAMPLE from SCENARIO	COMMENTS
T&E TASK 1. **Check mission picture**		We did not request or have access to paper based messages; this task was given zero priority because of the limited scope of the pilot.

DETAILED MEASURES	EXAMPLE from SCENARIO	COMMENTS
1a Accuracy in detecting relevant info within incoming message stream	1. AAW (ALG) provides SITREP: 60 seconds later ORO ranges down to AOI of SITREP. 2. AAW -AAWC advises of CAP. ORO immediately ranges down and selects this area of focus.	Time ref: 9:19:14 Time ref:9:35:20 Accuracy is assessed in terms of the ORO correctly taking an appropriate action based upon the message content,
1d Time to detect high salience message (i.e. of immediate relevance to context)	Less than 1 sec (example 2 above)	
1f Accuracy in ignoring lower priority messages	ORO ignores untimely SITREP from ASWD when about to fire missile.	Time ref 9:25:52
TASK 2. Relate new info Ops Room picture		
2a Accuracy in directing (communicates) info/direction resulting from message	Error example: CO reminds ORO about equipt malfunction on a hostile unit: ORO does not communicate implications to team.	Time ref: 9:36:50
2c Accuracy in comprehension of impact on pre-plans/response options/tactical situation	No specific examples observed	

Table 4.3: Examples of ORO centred MOPs collected during Pilot Trial
(continued on next page)

DETAILED MEASURES	EXAMPLE from SCENARIO	COMMENTS
TASK 3 Relate (new info) to RMP Includes aspects of build awareness across domains (RAP, MSP, MsubP).		Generally requires probe method not available in ORTT
3d Taking appropriate action as a result of updated RMP	ORO has been monitoring an unknown contact (2207). ORO immediately calls to SWC attention, trk gets ID as incoming missile ORO advises OOW where to monitor and advises CO for action stations.	Time ref: 9:24.24- 9:24.50. Entire sequence takes 37 seconds.
3f Accuracy in assessing the integrated tactical picture	ORO considers role of 2400 in possibly relaying targeting information to sub-surface threat.	The analysis was not followed through to determine if this was an accurate assessment. Although is clear that the ORO has considered this as a possibility.
TASK 7.1 Detect changes in tactical situation		
7.1c Time to detect new threat	8013 - hooked in 3 secs	9:24.24
7.1d Time to detect change in threat status	2400 from unknown to hostile: 38 secs	9:28:30. This is the time between the EWS making the correlation and REG making it hostile. In this particular context the MOP reflects TG AAW team performance rather than that of the ORO on HAL.
TASK 7.2 Determine threat priorities across domains		
7.2a Accuracy in ranking threat priorities across domains	Switches from assessing sub-surface threat (not imminent) to more immediate air threat.	9:24.24 9:29:15 During time of potential threats on both surface and sub-surface, the ORO and CO concentrated on surface action and left ASWC to handle sub-surface.
SUB TASK 7.3 Assess threats-within a specific warfare domain. Identify track threat priority		
7.3a Accuracy in identifying threat priorities	Several examples of where ORO changed focus to deal with more immediate threat. No errors detected.	A more complex example was when two aircraft (222/3) had initially been assessed as missiles; once they were ID as aircraft, (the ORO observed that they were jinking) the CO changed from salvo to single shot because they were easier targets.
TASK 10 Manage ship surveillance		
10a Accuracy recognising problems in detect to resolve process	Example 1: One error in ID went undetected by the SWC and ORO for several minutes. Example 2: Error in monitoring warning sequence to 2400	Notes taken during scenario. 9:19.09 & 9:22.45
10b Time to recognise problems in detect-to-resolve process	Trk 2207: 8 secs to recognise that resolve has not started on this and notifies SWC	9:24.27

Table 4.3: Examples of ORO centred MOPs collected during Pilot Trial (continued from previous page)

It should be remembered that the above MOP areas were selected on the basis of their relevance to ORO picture building and the potential impact of MSDF technology. MOPs related to ORO management of processes, teams and responses to threats were assigned a lower priority for the present trial. However, it should be noted that we were able to observe events and ORO actions

that would support the collection of MOPs in these areas. For example, during a missile engagement (reference 9:25.40) the ORO accurately monitored a failed missile firing by the SWC and took over the missile launch.

MOPs for contact detection & identification (air warfare examples)

DETAILED MEASURES	EXAMPLE from SCENARIO	COMMENTS
TASK 4.1 Identify friendly aircraft		Several occurrences in observed scenario. N=2 examined in detail
4.1a Accuracy in identifying friendly aircraft	One target ID correctly immediately, one ID after several minutes on the radar plot. Final accuracy rate = 100%., but one error in ID went undetected by the SWC and ORO for several minutes.	ASPO made trks 2224/5 friendly. These tracks not noticed by ARRO until 31 sec later.
4.1b Mean time spent in identifying friendly aircraft	Time to ID single friendly a/c=44 sec (Trk2412)	9:28.50 May not be a representative measure as rate of background air traffic was low for this scenario
TASK 4.2 Identify hostile/suspect aircraft		
4.2a Accuracy in identifying hostile / suspect aircraft	Accuracy 100%. All hostile AC were eventually identified; in some cases they remained suspect for a time before being correctly ID. No hostile a/c was ID as friendly. Trks 2222/3: initially suspected as missiles assessed quickly as a/c	Trks 2400, 2222/3. This delay in making Hostile is not to suggest a failure in the team. The appropriate criteria for Hostile were not achieved until the ESM intercept on the Mainstay
4.2b Mean time to identify hostile/suspect aircraft	Example 1: Trk 2400 Time to make suspect=29 sec Time to make hostile 10:08 (by REG) Time to ID as hostile: 9 minutes-14 secs based on EWS correlation TRK2217 Example 2: Trks 2222/3 SWC changed prelim ID from exocet to a/c in 22 sec based on flight pattern.	9:18.40 Initially correctly ID as suspect-subsequently correctly ID as hostile based upon new, more detailed information. 9:32.40
4.2c Total number of queries or total time spent in querying team for additional info	Example 1 Trk 2400: Eight communications among AAW team Example 2: One error of miscommunication between ORO and SWC (error was semantic rather than a missed comm)	Comms involving the SAC - not counted
TASK 4.3 Identify neutral aircraft		**Did not capture this event in scenario**
TASK 4.4 Identify NU tracks (non-updated)		**Not normally included in scenario in ORTT**

Table 4.4: Examples of Detect to Resolve MOPs (air contacts) collected during Pilot Trial (continued on next page)

DETAILED MEASURES	EXAMPLE from SCENARIO	COMMENTS
TASK 4.5	**Identify tracks reported by ownship or, conversely, by other participating units (Pus)**	**Not relevant in this scenario because of TG taskings/responsibilities.**
4.5a Accuracy identifying air tracks being reported by ownship		Not a relevant measure
4.5b Total time spent locating air tracks being reported by ownship		Not a relevant measure
4.5c Total number of queries or total time spent in querying team for additional info		Not a relevant measure
TASK 4.7	**React to threat track symbology LINKed by consort not on video**	
4.7a Time to recognise symbology not on video		**N/A in ORTT**
4.7b Time to order remedial action		**N/A in ORTT**
TASK 4.8	**React to LINK not gridlocked**	
4.8a Time to recognise LINK not gridlocked		**N/A in ORTT**
4.8b Time to order remedial action		**N/A in ORTT**
TASK 4.9	**Resolve ambiguous/dual tracks**	
Accuracy in resolving dual tracks	Example 1: Linked trk 2404/local trk8011. Example 2: Linked trk 2404/localtrk8027	Time ref: 9:23.04 Time ref: 9:27.56
Time required to resolve dual tracks	Example 1: Linked trk 2404/local trk8011. 51 secs - manually by ARRO Example 2: Trks 2404/8027 - 81 secs manually by ARRO	

Table 4.4: Examples of Detect to Resolve MOPs (air contacts) collected during Pilot Trial (continued from previous page)

4.5.2 Sub-surface event series: description and overview

The relationship among the various main events and actions for subsurface contacts is show in a second GANTT style chart (Figure 4). There are two submarine threats in this scenario, an OSCAR class anti-ship missile firing submarine and an AKULA class attack submarine. The Task Group has two AOPs close by, based on time late locating information provided by intelligence. The earlier SSN 19 missile attack has provided evidence that the OSCAR submarine at least is in close proximity.

- At 10:00 the ASWC on Halifax reported a sonar contact, Track 2275, at 3 NM from Halifax. It was almost immediately classified as "poss sub low 2" and Halifax responded by conducting an urgent torpedo attack in accordance with the preplan.
- Approximately 30 seconds later, Halifax ASWD changed Track 2275 classification from "poss sub low 2" to "poss sub low 1". It is possible that it may have been incorrectly entered into the system previously.
- At 10:02 HAL then reassessed Track 2275 as poss sub low 2. HAL then initiated a cordon search and attack plan (comprising HAL, REG and associated helo assets) in the vicinity of this contact and subsequently requested an additional helo added. REG queried the HAL assessment of 2275, since there had been no change in course or

speed of the contact in response to the torpedo attack. Of interest, there is no immediate reaction from HAL and it takes a further eighteen minutes before this contact is re-assessed.

- During the following 11 minutes, the ORO ranged in from 256 to 16 NM for fifteen seconds, presumably to focus on the subsurface contact, then ranged out again to 128NM to watch ongoing air contacts.
- At approximately 10:11 ALG helo reported a subsurface contact from a sonobuoy dropped prior to the first contact, classified as "poss sub low 1".

This contact, Track 2304, is incorrectly entered into system at the same position as the reporting helo rather than at the bearing and position reported by the helo. A discussion between the ASPO and the ASWD some three minutes later resulted in this track plotting error being rectified.

- At 10:15 a new subsurface contact, Track 2463, appeared as a Link track from REG.
- By 10:16 Track 2463 had been classified as an Akula class sub and in response, REG conducted an urgent torpedo attack.
- Immediately following, Track 2463 was made hostile by REG and classified as "poss sub low 1".
- Shortly thereafter REG reported holding blade (sonar operator hears propeller) on Track 2463 providing additional evidence that it was a sub.
- At 10:16, Halifax's helo reported no Madman (no Magnetic Anomaly Detection) when over Track 2275, which does not support the assessment of 2275 as a sub and is consistent with the earlier questioning by REG of the "poss sub" classification.
- At 10:17 REG detected a torpedo and the bearing line suggests that is associated with Akula hostile sub 2463. The situation depicted on the ASPO display at this time is shown in Figure 5.
- Somewhere between 10:17 and 10:19 hostile Track 2463 was changed to Track 2467 while the torpedo was assigned bearing line 2463. The ASWD immediately provided a SITREP to the ORO with regards to Tracks 2275 and 2463, which lasted approximately 50 seconds.
- At 10:18.18 REG reassessed Track 2467 from "poss sub low 1" to "prob sub" based on the torpedo.
- At 10:19, Halifax's helo reported Madman (detects metal) when over hostile Track 2467, providing still further evidence that it is a sub. At about this time, surface contacts (7607,7610) appear and consequently, the ORO must distribute his attention between building the surface and subsurface picture.
- At 10:19 Halifax correctly reassessed Track 2275 as a decoy and changed it to Track 2310, classified as a hostile non-sub.
- At 10:20, as a result, Track 2467 is reassigned as Track 2275, the contact initially believed to be a hostile sub.

In summary, the general picture that emerges from this series of events is one in which there is greater uncertainty concerning both target identity and location compared with the air picture. There appears to be a tendency to initially classify sub-surface unknowns as possible hostile, while more data are gathered to verify the initial classification. The record shows that picture building, contact resolution and threat assessment are ongoing processes that result in the integration of more information over time concerning contacts which leads to the refinement of the identification. Further, the time and pace with which contacts are processed is clearly slower than that of air warfare. The gathering of contact information is clearly a team process with contributing

information coming from deployed helos, other ships and sonabuoys. Many of the communications that support this process take place on external circuits.

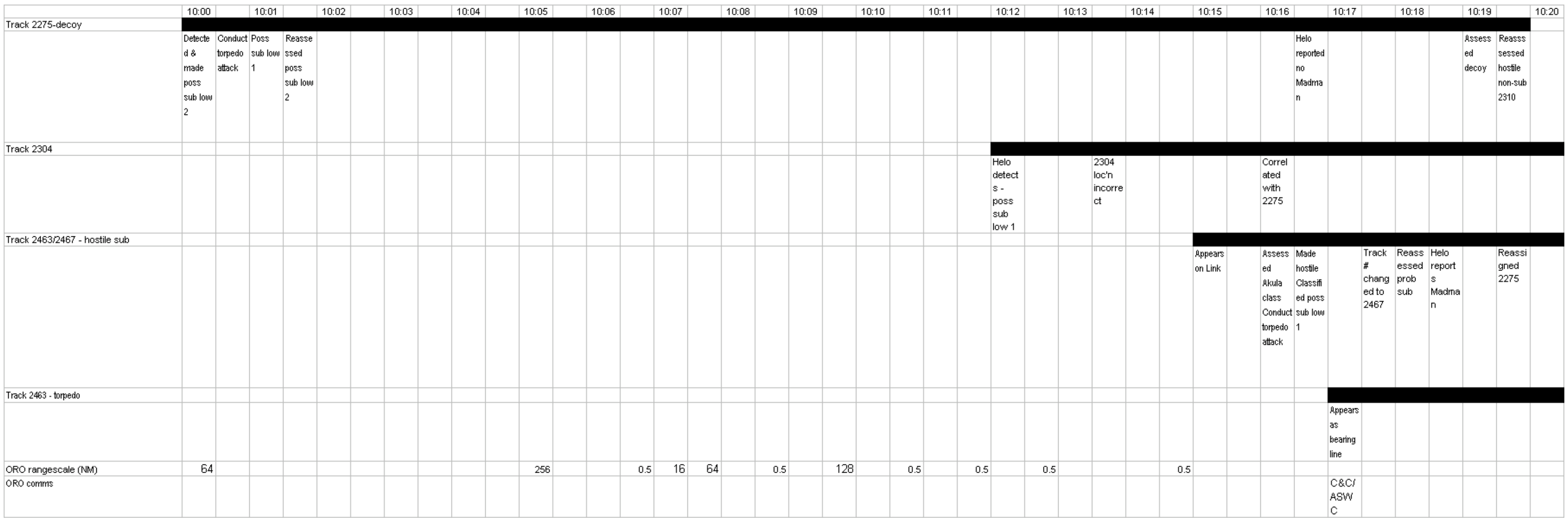

Figure 4.4: Gantt chart showing main events and actions for subsurface contacts

Figure 4.5: Screen capture of ASPO (RT2) CCS display at 10:17 in scenario

4.5.2.1 Analysis of ORO sub-surface contact activities

Although the ORO is active dealing with above water threats, there is little in the CCS data record to indicate what the ORO is doing about the sub-surface threat during this series of events. There is no evidence that the ORO hooks any of the sub-surface contacts, discusses the situation with the ASWD or CO, except for one occasion at seventeen minutes into the scenario, when the SWC gives the ORO a lengthy SITREP concerning two suspicious contacts. It should be remembered that overlapping with this series of sub-surface events are a number of surface contacts. More analysis of the communication records would be required to establish exactly what the ORO was doing during these events.

4.5.2.2 MOPs

Several relevant MOPs were able to be extracted from this series of events and are shown in the following table. For simplicity and clarity only those tasks and MOPs relevant to the sub-surface action are presented, rather than reproducing the MOP table in entirety. To the level that we were able to analyse the data record (including ORO comms and CCS action) there were insufficient data to generate any ORO centred MOPs. Hence the examples provided below are more relevant to the detect-to-resolve process

DETAILED MEASURES	EXAMPLE from SCENARIO	COMMENTS
TASK 4.1 Identify friendly sub-surface		
4.1a Accuracy in identifying friendly sub-surface	Correct ID of location of friendly bullpen.	Team created bullpen (defined geo area in which a friendly sub is operating) and discussed implications of this during picture compilation. (From notes and observation of CCS).
TASK 4.2 Identify hostile/suspect sub-surface		
4.2a Accuracy in identifying hostile / suspect sub-surface	2275: Although this is finally assessed correctly, there are several incorrect assessments in the process of gathering more information. 2304: Correct ID 2463: Correct ID	
4.2b Mean time to identify hostile/suspect sub-surface	2275: RT-poss sub:25sec 2275: RT-reassess pos sub low2=162 sec 2275: RT-final assesment=1935 sec 2304: RT prb sub=254 sec 2463/7: RT hostile=51 sec	There is continuing re-assessment of this contact.
TASK 4.3 Identify neutral sub-surface		No examples in scenario
TASK 4.9 Manage tracks		
Accuracy in managing tracks	One example of poor track management. The decoy (track 2275) should have maintained that track number throughout. For some reason it was reassigned track number 2310 even after it was correctly ID as a decoy. The AKULA was initially 2463 and should have stayed as this. It was changed first to 2467 and then to 2275, which was really the decoy's track number.	Post event analysis by SME
Time required to manage tracks		
TASK 10 Manage ship surveillance		
10a Accuracy recognising problems in detect to resolve process	ORO fails to see error in plotting track 2304 (reported from helo). Error is corrected by ASWD.	10:14.04
10b Time to recognise problems in detect-to-resolve process	Above example takes 30 sec to correct	10:14.44

Table 4.5: Examples of Detect to Resolve MOPs (sub-surface contacts) collected during Pilot Trial

4.5.3 Surface event series: description and overview

This series of events occurs after the preceding air series and runs from approximately 10:18 to 10:36.

A GANTT style chart (Figure 6) shows the relationship among the various main events and actions for surface contacts.

Prior to the appearance of surface contacts, the underwater warfare team has been engaged in underwater picture building for approximately 20 minutes. At the time the first surface contact appears, the ORO and underwater warfare team are tracking an Akula class hostile sub (Track 2275) that has recently fired a torpedo at Halifax. Figure 7 presents a screen capture of the ASPO CCS display at 10:16:49 showing an area of probability (AOP) associated with Track 2275. Then:

- At approximately 10:18 surface contacts, Track 7610 and 7607, appeared. 7610 was made suspect by the ASWD before 10:19 based on its proximity to the location where the two CAP aircraft had been shot down enroute to intercepting the Mainstay, and unassociated ESM.
- At 10:20, Track 7607 is made suspect based on its relationship to the AOP of one of the Surface Action Groups (SAG), however, by 10:21 7607 is reassessed as assumed friend based on its radar profile.
- At about the same time, two more surface tracks, 7612/3 appeared and were made suspect almost at once.
- Just past 10:22, the Commander Task Group (CTG) directs the MPA to issue a verbal warning to 7612/3, which are assessed probable Surface Action Group (SAG) based on ESM. Immediately after, two additional surface contacts, Track 7614 (30 nm to the south) and 7615 (40nm to the north) appeared.

At this point the ORO is ranged out suggesting that he has not been following these events closely, however, at about 10:24 the ORO ranges down to 8NM, although the reason for this cannot be readily determined.

- Just before 10:25, it is recommended that Tracks 7614/5 is made suspect due to proximity to SAG 1B AOP. The ASuWC (AS) responds agreeing that 7615 is suspect but recommended 7614 remain unknown as the MPA assessed it too small for a warship.
- At 10:25, REG makes Track 7610 hostile based on associated ESM, proximity to downed aircraft and behaviour. However, Vancouver recommends to AS that 7610 is outside weapons range and therefore no warnings should be issued by the MPA.
- At 10:26, the MPA reports that 7614/5 are non warships based on their radar profile, and as a result, AS recommends that 7614/5 are classified assumed friend.
- At about 10:28 MPA reports that 7612/3 did not respond to verbal warning given six minutes prior.
- At 10:33 new surface tracks 7620/21/22/23 are received from MPA. Although there is no other evidence suggesting that these are possible warships, Regina recommends to Vancouver that 7620/21/22/23 are made suspect based on area of probability of SAG 1B, and Vancouver agrees.
- Just past 10:33 two incoming missiles, Tracks 2320/1 (local tracks 8318/9) appear on the SWC display. (These may be missiles from 7612/3 given that they did not respond to verbal warning by the MPA.)

- At 10:34, Regina's helicopter reports that suspect Track 7620 is a civilian merchant ship based on its radar profile and is therefore made assumed friend by 10:35.

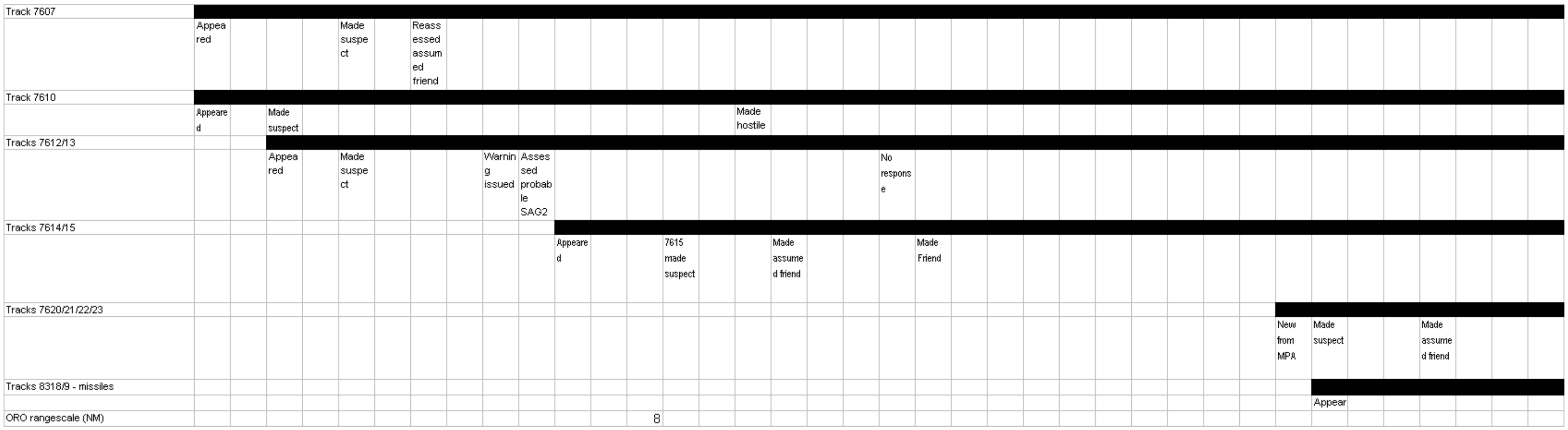

Figure 4.6: Gantt chart showing main events and actions for surface contacts

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4.5.3.1 *Analysis of OROs surface contact activities*

There are very few communications and ORO actions to indicate that the ORO is tracking these surface contact activities closely. The ORO ranges down only once during this period for an unknown reason.

4.5.3.2 *MOPs*

Again, we have selected relevant examples of MOPs for the detect-to-resolve process for surface contacts. There are no ORO centred MOPs that can be extracted without much deeper analysis of the original scenario record.

DETAILED MEASURES	EXAMPLE from SCENARIO	COMMENTS
TASK 4.1 Identify friendly surface		**Did not capture this event in scenario**
TASK 4.2 Identify hostile/suspect surface		
4.2a Accuracy in identifying hostile / suspect surface	Two examples correctly identified	
4.2b Mean time to identify hostile/suspect surface	7610: RT assumed sus= 133 sec 7610: RT hostile= 420 sec 7612: RT assumed sus= 40 sec 7612: RT assumed prob sus= 90 sec	
TASK 4.3 Identify assumed friendly surface		
4.3a Accuracy in identifying friendly surface	Three examples all correctly identified	Each initially made suspect
4.3b Mean time spent in identifying friendly surface	7607: RT assumed friend= 176 sec 7615: RT assumed friend= 166 sec 7612: RT assumed friend= 165 sec	Initially made suspect (133 sec)pending further evidence Initially made suspect (50sec) pending further evidence Initially made suspect (15 sec) pending further evidence

Table 4.6: Examples of Detect to Resolve MOPs (surface contacts) collected during Pilot Trial

4.5.4 Summary of MOPs that may be extracted from the ORTT data record

Following this analysis of a representative data record, its overall potential for extraction of data pertinent to the full list of possible MOPs has become clearer. To this end, the full list of T&E MOPs developed in an earlier report (Matthews, Webb & Keeble, 2001) has been revisited with a view to providing a commentary on what is feasible and practicable using the ORTT data record and Debrief function.

DETAILED MEASURES	STATUS	COMMENTS
T&E TASK 1 Check mission picture		
1a Accuracy in detecting relevant info within incoming message stream	**Air example provided**	We did not request or have access to paper based messages; associated MOPs based on paper message flow were given zero priority because they are unlikely to be a source of useful data in evaluating the impact of MSDF technology. However, it should be remembered from the CTA that these are an important source of workload for the ORO and should be examined in a full T&E trial.
1b Accuracy in ignoring irrelevant info	Not investigated	Feasible, but given the labour required to collect a large enough database of communications for reliable data, this should probably have a lower priority.
1c Total time spent in comms dealing with incoming info	Not investigated	This is feasible. Given the labour intensive nature of this task, it could not be undertaken within the scope of the pilot trial. Although, we believe this to be an important measure that should be computed in future trials.
1d Time to detect high salience message	**Air example provided**	
1e Accuracy in requesting additional info (i.e. number of messages that required follow up that resulted in ORO request for more info)	Not investigated	This is feasible, but given the labour required to collect a sufficiently large database of communications to establish reliable data, this should probably be assigned a lower priority, given that 1c is likely to provide a good general measure.
1f Accuracy in ignoring lower priority messages	**Example provided**	Not done in training scenario (only at sea) - may happen by chance in ORTT, as was observed.
T&E TASK 2. Relate new info Ops Room picture		
2a Accuracy in directing (communicates) info/direction resulting from message	**Air example provided**	
2b Accuracy re message content in briefing appropriate station	Not investigated	
2c Accuracy in comprehension of impact on pre-plans/response options/tactical situation	**Air example provided**	
2d Accuracy in recognition of impact on Ops Room capability	N/A	No opportunities. May not be possible except at sea when capabilities become degraded. This is not normally done in land based training.
2e Total time spent in relaying info re Ops Room status	Not investigated	Feasible, but time consuming. Suggest lower priority for future trials
T&E TASK 3 Relate (new info) to RMP, RAP Includes aspects of build awareness across domains (air, surface, sub-surface).		
3a Accuracy of salient info within RMP *prior* to new message	Not investigated	Not feasible unless ORO provides a timely SITREP as conditions demand.
3b Accuracy of salient info within RMP *after* new message	Not investigated	Feasible if we infer ORO subsequent actions are based on new info.
3c Time for ORO to complete understanding of new info regarding RMP	Not investigated	Feasible if we infer ORO subsequent actions are based on new info. However, comprehension may not necessarily lead to a specific, observable ORO behaviour.
3d Accuracy in taking appropriate action as a result of updated RMP	**Air example provided**	
3e Total time spent on SSD relating new info to RMP	Not investigated	This may be too complex to assemble, since start and end points are not necessarily definable.
3f Accuracy in assessing the integrated tactical picture	**Example provided**	

Table 4.7: Summary of MOPs potentially collectible in the ORTT based upon pilot trial (continued)

DETAILED MEASURES	STATUS	COMMENTS
T&E TASK 4 Relate new info to air, surface, sub-surface picture		
SUB TASK 4.1 Identify friendly contact (air, surface, sub-surface)		
4.1a Accuracy in identifying friendly contact	**Air, surface examples provided**	
4.1b Mean time spent in identifying friendly contact	**Air, surface examples provided**	
4.1c Total number of queries or total time spent in querying team for additional info	Not investigated	Feasible. Requires time consuming analysis of comms
SUB TASK 4.2 Identify hostile/suspect contact		
4.2a Accuracy in identifying hostile / suspect contact	**Air, surface, sub-surface examples provided**	
4.2b Mean time to identify hostile/suspect contact	**Air, surface, sub-surface examples provided**	
4.2c Total number of queries or total time spent in querying team for additional info	**Air example provided**	
SUB TASK 4.3 **Identify neutral contact**	Not investigated	Feasible based upon methodology in 4.2
SUB TASK 4.4 **Identify NU tracks (non-updated)**	Not investigated	Not normally included in scenario in ORTT
SUB TASK 4.5 **Identify tracks reported by ownship or, conversely, by other participating units (PUS)**	Not investigated	Possibly feasible; information might be obtained from more in-depth analysis of comms, but would likely require debrief of team.
SUB TASK 4.6 **Identify own force engagement status**		
4.6a Accuracy identifying air tracks being engaged by ownship or ships in TG	Not investigated	Needs a T&E probe-probably not available
4.6b Response time to be ready to engage correct track	Not investigated	Feasible
4.6c Total number of queries or total time spent in querying team for info	Not investigated	Feasible. Requires time consuming analysis of comms

Table 4.7: Summary of MOPs potentially collectible in the ORTT based upon pilot trial (continued)

DETAILED MEASURES	STATUS	COMMENTS
SUB TASK 4.7 React to threat track symbology LINKed by consort not on video		
4.7a Time to recognise symbology not on video	Not investigated	N/A in ORTT
4.7b Time to order remedial action	Not investigated	N/A in ORTT
SUB TASK 4.8 React to LINK not gridlocked		N/A in ORTT
4.8a Time to recognise LINK not gridlocked		N/A in ORTT
4.8b Time to order remedial action		N/A in ORTT
SUB TASK 4.9 Resolve ambiguous/dual tracks		
4.9a Accuracy in resolving dual tracks	**Air example provided**	
4.9b Time required to resolve dual tracks	**Air example provided**	
4.9c Total number of queries or total time spent in querying team for info	Not investigated	Feasible. Requires time consuming analysis of comms but is a desirable measure to be collected in future trials.
T&E TASK 7 Assess threats -generic		
SUB TASK 7.1 Detect changes in tactical situation		Evidence from the scenario suggests that measures 7.1a-7.1d can all be considered as part of threat identification in the detect to resolve cycle.
7.1a Accuracy in ID new threats	**Examples provided: air, surface, sub-surface**	
7.1b Accuracy in ID changes in threat status	**Air, surface, sub-surface examples provided**	
7.1c Time to detect new threat	**Air, surface, sub-surface examples provided**	
7.1d Time to detect change in threat status	**Air, surface, sub-surface examples provided**	
7.1e Time to provide SITREP in response to request	Not investigated	No example in scenario. In general, it is not possible to determine start point of SITREP creation without a probe or unless the CO requests one.
7.1f. Accuracy in SITREP contents	Not investigated	Feasible: will require post-event analysis by SME
SUB TASK 7.2 Determine threat priorities across domains		
7.2a Accuracy in ranking threat priorities across domains	**Example provided**	Post-event analysis by SME indicated some surprise over the apparently low priority the ORO (and the CO) gave the ASW threat as it was building, given the lethality of a torpedo strike compared with that of a missile.
7.2b Time to assess threat priorities across domains	Not investigated	It would be difficult to determine the start point for this time measure, without a probe methodology.

Table 4.7: Summary of MOPs potentially collectible in the ORTT based upon pilot trial (continued)

DETAILED MEASURES	STATUS	COMMENTS
SUB TASK 7.3 Assess threats-within a specific warfare domain. Identify track threat priority		
7.3a Accuracy in identifying threat priorities	**Air example**	
7.3b Total time to identify highest priority threats	Not investigated	This is probably not a feasible approach in the ORTT.
7.3c Time to annotate CCS with CPA	**No evidence done for air tracks**	Feasible, but 7.3e may be a better MOP for this process of assessment.
7.3d Accuracy in determining CPA	**No evidence done for air tracks**	Feasible, but 7.3f may be a better MOP for this process of assessment
7.3e Accuracy in determining lethality	**Air example**	Possible, given appropriate scenario circumstances
7.3f Time to determine lethality	Not investigated	Possible, given appropriate scenario circumstances
7.3g Time to create a SITREP	Not investigated	Not possible to determine start point of SITREP creation without a probe or unless the CO requests one.
7.3h Accuracy and completeness of SITREP		Feasible: will require analysis by SME
SUB TASK 7.4 Analyse history profile of hostile surface	Not investigated	Not relevant; no repeated action in scenarios
T&E TASK 9 Assess sensors:	Not investigated	Not feasible in existing scenarios
T&E TASK 10 Manage ship surveillance		
10a Accuracy recognising problems in detect to resolve process	**Air, sub-surface examples**	
10b Time to recognise problems in detect-to-resolve process	**Air, sub-surface examples**	
10c Appropriateness of remedial action to correct errors	**Air, sub-surface examples**	

Table 4.7: Summary of MOPs potentially collectible in the ORTT based upon pilot trial

To summarise, of these sixty potential MOPs, we have been able to provide concrete examples for nineteen and believe that a further eleven are feasible, given appropriate scenario circumstances and/or time for more in-depth analysis. Of significance is the fact that we are able to extract quantifiable MOPs for the following ORO core functions (based upon the CTA): building/maintaining the global, mission and tactical pictures, managing ship surveillance, managing ship's response (including contact classification). Other sub-functions such as the assessment of communications and weapons would be amenable to MOP data extraction, if the scenario circumstances provide the appropriate context. The only areas where it does not seem feasible to extract MOP data from the ORTT record is for "assess teams", "assess schedules" and "assess sensors" (sub-functions of "managing ship's capability").

Of importance to the future evaluation of COMDAT MSDF technology, we have clearly demonstrated that the ORTT data record provides us with a capability to capture a number of MOPs that relate to the critical processes of the detect-to-resolve cycle and picture compilation and associated communications.

4.5.5 Recommendations for subset of MOPs to be used for assessing COMDAT MSDF in upcoming trials

As shown in the above section, many MOPs may be feasibly collected in the ORTT that are directly related to Ops Room and ORO critical functions. Some of these MOPs are more relevant to MSDF evaluation than others, some are more feasible to collect than others, and amongst those, some are more labour intensive to collect than others. Having assessed each of these issues for each MOP in turn, we believe that the following subset of MOPs may be the most diagnostic and practical for assessing MSDF technology i.e. the functions these MOPs represent should benefit from MSDF technology. For example, with MSDF, operators should be more confident and possibly take less time to identify and track contacts, require fewer communications to resolve contact ambiguities than at present, and spend less time micro-managing their sensors to resolve track ambiguities and the like. The outcome of this should be more time spent assessing the tactical implications and more effective within and between team communication about tactical rather than contact and track management issues.

MOP DESCRIPTION	DETAILS	COMMENT
Accuracy in assessing the integrated tactical picture		Includes: multi-sensor/source and wide area picture integration, surface/sub-surface picture compilation
Total time in communication	Sum total of time in net-based comms	Total communications across team, TG and other sources of information
Communication errors	Percent of comm errors as a function of total number of comms per event	Communication errors can be semantic, requests for repetition, untimely, missed.
Wide area picture quality compared with ground truth and/or information available to the Ops Room	Navy SME judgments on behaviourally anchored rating scales.	Scales to be developed by SMEs prior to trial.
Identify hostile/suspect contact		These can be applied to air, surface and sub-surface contacts
Accuracy	Percent correct ID	May also be expressed as error rate
Response time per contact	Average time from triggering event to interim or final ID.	
Total time in communication	Sum total of time in net-based comms	Total communications across team
Communication errors	Percent of comm errors as a function of total number of comms per event	Communication errors can be semantic, requests for repetition, untimely, missed.
Manage ambiguous tracks		Covers all aspects of ambiguous tracking whether from sensor degradation to multiple sensors holding same contact and reporting/comm errors on tracks
Accuracy in resolving dual tracks	Percent of dual tracking situations that are correctly resolved	
Time required	Average time per dual track situation before correct solution is obtained	
Total time in communication	Sum total of time in net-based comms related to resolving tracks	
Manage ship surveillance		ORO centred measures
ORO accuracy in recognising problems in detect to resolve process	Number of correct IDs by ORO divided by number of opportunities	May be few of these with experienced team
Time to recognise problems in detect-to-resolve process	Time from first indication of problem until resolution	

Table 4.8: Recommended MOPs for assessing MSDF impact

4.5.6 The efficiency of the data extraction process

4.5.6.1 ORTT CCS and Communication data record

The pilot trial has provided an opportunity to explore the ways in which the ORTT data record may be analysed for the purposes of extracting MOP data. The experience of doing this and learning effective and less effective approaches has led us to a better appreciation of the time required to extract data of interest. Generally speaking, the CCS record may be analysed more efficiently than the communication record for a number of reasons. First, we can view up to three CCS consoles simultaneously during replay, whereas we can only monitor one communication net. Second, the CCS record is relatively slow moving and allows the information to be extracted with fewer passes through the same segment. In contrast, it may take a number of replays of quickly spoken messages to get the content. Third, to fully track down the flow of information in complex situations, it may be necessary to examine several communication nets using many iterative steps.

There are three stages to the data analysis process.

- The first is a re-creation of the critical scenario events along a common time base. This includes all relevant communications (source, destination, content), CCS contacts (location, radar held, status), changes in contact status, ORO range and hook selections (possibly also those of the SWC and ARRO, ASPO) and any contextual explanatory notes for each entry from the T&E team. Based upon our first attempt at this process during the T&E trial it took approximately twelve hours for three persons to re-create approximately 90 minutes of scenario. Part of this time was spent in reviewing the whole scenario for the events to be re-created and part in figuring out a suitable methodology. It should be noted that real-time access to the ORTT playback tools and data record is required to conduct this stage.
- The second stage is a "semantic" analysis of the output from the first stage to comprehend the chain of events and the Ops Room team behaviours.
- The third stage is the extraction of the relevant MOPs using the products of the first two stages. These second and third stages have taken approximately thirty person hours and have been conducted off-site from the ORTT.

With the benefit of lessons learned from this pilot trial, greater efficiencies in these processes will evolve, especially if the goal is to concentrate on a subset of measures rather than trying to evaluate the overall potential of the ORTT to support all of the MOPs that have been initially identified.

4.5.6.2 Keystroke file

We conducted a brief review of the keystroke file in order to assess its usefulness in extracting some micro-level timing data. In its present format, it does not facilitate rapid data extraction, as the record has to be scanned sequentially to find data of interest. For security reasons, the data may not be printed out and there is no software to translate the record into one that is compatible with a spreadsheet format. Should such a capability be made available or created, then the simple spreadsheet macros should allow the rapid extraction of important data related to designated keys or keystroke sequences. An example of this might be the elapsed time between the ARRO entering a track number in the system and the time when that track is later correlated with other data such as EW.

4.5.6.3 Audio/video tape record

This medium provides a audio-visual data record of the interactions between the ORO and other members of the team in the Ops room, as well as the associated face to face conversations that are not recorded over a circuit. We did not find a need during the analysis of the data record to consult this tape.

Based upon what we have learned, we believe that this record may only need to be accessed at specific times when critical information appears to have been passed outside of the electronic communication nets. As far as we could tell, the scenario events we saw neither provided a large body of text messages that were hand delivered to the ORO nor a need for face to face discussions among the team. However, it should be acknowledged that we did not give high priority to find evidence of such communication given the analysis time available on site. Furthermore the reports of actual operations at sea suggest that, the volume and significance of text messages at least, is far greater than that simulated in the ORTT.

Thus, it may have been possible that the ORS was busy communicating face to face with many team members, but we didn't see this because we weren't looking. It certainly wasn't evident from the ORTT record, but it may have happened. Notwithstanding this possibility, it does seem that this scenario did not place as high a requirement for face to face comms as a real scenario at sea would. Many of the face to face comms at sea are between the ORO/ORS and often deal with Ops Room management issues that typically do not arise in a training environment.

In general, we conclude that for future MOP data extraction, this data record will not have to be analysed in its entirety but only minimally consulted where scenario circumstances warrant.

4.6 Discussion

4.6.1 Review of goals

First, we will review our success in meeting the goals that were set out in Section 2 of the report.

- **Observe a training scenario in action and note areas of interest for MOPs**

We were able to observe approximately three hours of training with an intact ship's Ops Room Team. However, the scenario observed was somewhat different from the regular training scenario in that it required the ship to pursue a possible hostile contact without the usual context of a TG. This contrasts with a typical training scenario in which the ship under training responds to a series of air, surface and sub-surface contacts and threats in a typical TG format. The more typical training scenario was considered to be more representative and appropriate for the analysis of MOPs and extraction of data. Thus, the scenario under observation did not allow us to note specific scenario events that would be the focus of MOP analysis. Instead, we used a record of a more typical TG scenario record from the previous day, which meant that there was some additional analysis overhead in first reviewing the record for areas of interest for analysis.

- **Assess the practicality of inserting T&E "tags" into the scenario record during scenario execution to assist in subsequent MOP analysis**

Because we were not present during scenario execution, we were not able to do this. However, our discussions with the ORTT technical manager suggest that this would be easy to do for future studies.

- **Develop a methodology for analysis and recording the captured data**

This was successfully accomplished and will be refined for future trials based on lessons learned.

- **Analyse the digital video and audio record (using ORTT Debrief software) to build the ongoing team picture and communications for selected events**

As the detailed analysis in the results section shows, we were successfully able to accomplish this for air, surface and sub-surface events.

- **Analyse the supplementary video and audio record (using standard VCR) to build the ongoing team picture and communications for selected events**

There was insufficient time to attempt this in detail. However, the analysis of the data record suggested that for this series of events and team responses, there would be little added value in doing this analysis.

- **Derive quantifiable MOPs from the previous analyses**

A number of examples of MOP data across a broad spectrum of events were successfully analysed.

- **Determine range of potential MOPs that could be assessed using the ORTT**

This was accomplished and the results are shown in summary format in Table 6.

- **Make recommendations for the specific subset of MOPs that would be most suitable for assessing the impact of MSDF technology in future trials**

Twelve appropriate and logistically practical MOPs have been identified (Table 7)

- **Comment upon the effectiveness and efficiency of the data extraction and analysis methodology and its implications for logistical and other support in future trials.**

Approximate estimates of the time and personnel resources required to extract MOP data are provided. Future trials will benefit from the experience gained and the process will become more efficient. Ultimately, the complexity of the events will dictate the level of support required for analysis. The analysis of communications, while important and with significant potential payback from several perspectives, is the most time consuming and least efficient, because of the inability to replay more than one network at a time. A technical solution should be sought to enhance the efficiency of communication analysis.

4.6.2 General assessment

Based on this Pilot Trial, we believe that the ORTT represents the best option available for collecting MOPs in future trials, whether the focus is decision support for the ORO, or other functions of the team that are relevant to the assessment of the impact of MSDF technology.

For the ORO, it was shown that it is possible to collect MOPs relevant to the entire detect to engage cycle:

- Building/maintaining the global picture
- Building/maintaining local air, surface, sub-surface pictures
- Exchanging information among Ops room team members
- Managing ship surveillance.
- Contact detection, identification and classification

- Implementing appropriate responses and
- Assessing the effectiveness of the response and any follow-on actions required.

In the cases of picture building, the MOPs we have been able to collect are dependent upon observable responses/actions/communications of the ORO. It does not seem feasible within the constraints of the ORTT training environment to "get inside the ORO's head" using a probe methodology that requires momentary interruption of the exercise to probe the situation awareness of selected players. The exception might be to request an occasional SITREP set in the context of the exercise. However, there are potential training benefits that come with the interruption probe approach. The possibility that use of the interruption probe could serve both training and T& E should be investigated in conjunction with the training community.

Areas such as the assessment of sensors, weapons, teams, and schedule seem less amenable to the collection of MOP data in the ORTT and are more dependent on the scenario context providing the right triggering conditions for ORO actions. This will generally be true of any land-based simulation facility and hence MOP development in these areas may require trials involving the ship at sea.

With respect to MOPs relevant to MSDF assessment and the picture compilation process, we have been able to demonstrate an ability to collect representative data in the **detect-to-resolve cycle** for air, surface and sub-surface contacts. We have also shown that we can identify, time and assess the accuracy of key events in this cycle, such as the exact times when targets are first detected, when assessed and when identified. Thus, it seems entirely feasible that we can collect quantitative data, expressed in unambiguous numerical terms that will allow the empirical assessment of the changes in task performance that are attributable to MSDF technology. Such MOP data will comprise for example percent correct detections, identifications, error rates, time spent in communications and communication errors.

Finally, it should be noted that the above MOP data should be regarded as concrete exemplars to prove the concept that quantitative data can be extracted from the ORTT record using a workable methodology. The numbers themselves should not be taken as being indicative or representative of baseline performance.

4.6.3 Data collection to support future MSDF TD trials

Wherever the location for evaluating the MSDF workstation in future TD trials, there will be two measurement requirements. The first will be to assess the performance of the primary tasks that as they are impacted by the MSDF technology, the second to provide baseline comparative data for these tasks against which to evaluate the technology.

With respect to the former, we have provided a set of MOPs that should permit the assessment of a broad range of tasks, and which could be readily adapted to generic picture compilation and contact resolution tasks that may be affected by the technology. These MOPs should be appropriate no matter the specific implementation of the workstation functionality that provides the technology and the particular constraints it might place upon how the MOP data are actually collected. At a practical level, and based upon previous TD trials, it can be expected that there will not be opportunities for multiple data runs with a reasonable number of trial participants. Hence, the data collected are likely to be constrained and at best indicative of performance trends.

It follows that if the TD trial data are not as extensive as would be optimally desired, then to have baseline, comparative data that are also limited in terms of reliability and generality, would militate

against the drawing of meaningful conclusions concerning the merits of the technology. It is suggested therefore that a stable baseline of performance data be collected in the ORTT across a range of scenario events (from existing training scenarios) that are comparable to the planned events for the TD trials. In this way we can at least establish a reliable and stable basis for comparison.

For the future, it may be appropriate to consider the degree to which the ORTT software can be upgraded to allow integration of MSDF, or other emerging technology, features. We have been told that this may not be difficult to accomplish compared with the level of effort required to integrate such features into the CSTC, particularly if reliable MOP data are to be collected.

4.7 Recommendations

1. To quantify evaluation of MSDF technology, two parallel sets of MOP data must be collected to reflect performance on relevant tasks with and without the technology. As a next step, and prior to the conduct of the MSDF trials, a full data collection trial should be conducted to generate the baseline comparative MOP data set (using the MOPs short-listed in this report) for MSDF relevant contexts and tasks. This would be conducted using ORTT records from ongoing scenario training with experienced ship teams. Data collection would be limited to the specific subset of MOPs relevant to the impact of MSDF technology.
2. To facilitate (1), LMC and the Navy should be requested to develop a standalone system for the "Debrief" software to allow it to function independently of the existing ORTT system. This will allow parallel, simultaneous analysis of data for T& E when the ORTT is being used for training. Doing this would greatly enhance the efficiency and cost-effectiveness of data extraction. If this is not feasible, it will impact only on the efficiency and cost of data collection and should not be though of as a pre-requisite for future work.
3. To facilitate the collection of data in the CSTC (should it be required), acquire, or make available, supplementary digital data capture, such as the DGx system.
4. If the MSDF TD is to be implemented in the **CSTC**, conduct a pilot trial in this facility to fully evaluate the ability to collect the required MOPs identified for the evaluation of the impact of the MSDF technology.
5. Conduct an evaluation of the capability of the COMDAT MSDF prototype workstation and software to collect MOP data for test and evaluation purposes.

4.8 References

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5. Technical Memorandum:

PROVISION OF NAVAL SME SUPPORT TO CONTRACTORS

5.1 Summary

5.1.1 Background

In the course of projects for the Navy or with Navy content, contractors have a need for Subject Matter Experts (SME) for blocks of time (e.g. several hours to several days) to participate in trials or to meet with contractors to explain operational procedures and processes. In some cases, contractors do not get the required mix of qualifications and experience from the Navy personnel who are available to be supplied. Equally, the Navy has to contend with potentially uncoordinated requests from multiple contractors. This Technical Memorandum addresses these problems and seeks to find a way to lessen demand and administrative burden whilst still providing the required SMEs to contractors.

5.1.2 Findings

It is clear that the Navy has a great number of demands on the time of its personnel; chief among them being National Defence. The longer term goals of research and development may conflict with the immediate goals associated with maintenance of a potent defence force. These conflicts also create long lead times for requests for SMEs that can also make it difficult to accommodate last minute changes in research and development projects.

This Technical Memorandum considered six options for the provision of SMEs:

- Retention of the current structure and approach;
- Creation of a centralised SME availability pool;
- Attachment of serving SMEs to a project;
- Payment of serving SMEs acting as consultants in their off-time;
- Creation of an independent SME pool of Navy retirees; and
- A hybrid approach.

The annex to this Technical Memorandum included a listing of the functions that must be covered by the SME pool:

- Radar tracking/Above water picture compilation;
- Underwater picture compilation;
- Electronic Support Measures (ESM);
- Fire control;
- Aircraft control;

- Warfare sub-team direction;
- Ops room direction; and
- Command.

Each function was described according to the positions it relates to, MOC/qualification/rank/experience, responsibilities, criticality and availability.

5.1.3 Conclusions

It was recommended that a hybrid approach be used, consisting of elements of the current system, attaching serving SMEs to a project, and paying SMEs in their off-time. Challenges to this hybrid approach would include negotiating the involvement of a dedicated SME on a project, setting SMEs up as self-employed consultants (or else paying them through Navy pay channels), and cultural barriers to 'moonlighting'.

5.2 Introduction

This memorandum addresses potential means of streamlining or reducing the demands made on DND to provide Subject Matter Experts (SMEs) to support contractors working for DRDC on various Navy projects. From the contractor's point of view, actual servicing of their needs is patchy – sometimes spot on, but sometimes misunderstood in terms of the need for currency and focus of experience. Conversely, from the Navy's point of view, contractors as a group can appear to be making similar, uncoordinated, and last minute demands on scarce resources.

While the demand for SMEs to support contractors will continue, it could be advantageous to investigate means of providing the support with reduced demand on limited naval resources, and in such a way as to lighten the administrative load of setting up the support. The concept of developing a pool of naval SMEs upon which to draw was first considered during work on the COMDAT project, where it became apparent that in the current operational climate the Navy had considerable difficulty providing current, qualified combat operators to support even moderate contractor requirements. This led to the broader investigation described in this memorandum of various options for providing naval SME support to contractors.

5.2.1 Definition of the Problem

Contractors frequently need SMEs to support the work they have been contracted to do. Because of the complexity of the naval operations environment, these SMEs must have had recent operational experience using the particular equipment or processes being studied. In the case of a combat team or sub-team, several SMEs with different qualifications or experience may be required concurrently. Also, to gain a consensus and cover a range of experience during interviews or focus groups, or to achieve statistical confidence in performance studies, two or even more SMEs with similar qualifications and years of experience may be needed.

Due to the Navy's demanding operational schedule and current personnel levels suitable SME support is difficult to arrange. Challenges include but are not limited to:

- Ships' combat operators are busy training or planning for upcoming operations, or are readjusting to home port routine after returning from deployment

- Many operators posted ashore have limited current experience in the positions required by the contractor's study
- There are few junior operator positions ashore to begin with
- There is no mechanism to which a scheduling authority or a contractor trying to plan well ahead could refer to identify operators on a coast-wide basis that may be available for support at any given time, resulting in the requirement to contact numerous units for each support request
- There are often multiple concurrent demands from contractors or other sources for the limited number of available SMEs
- The requirement to secure appropriate SME support results in long lead times for contractors, which can negatively impact work time lines
- The current process of securing SMEs makes it difficult to accommodate schedule changes that come about due to extraneous factors
- Contractors often require a degree of continuity in their SMEs for a period of days; the more important is the continuity issue or duration, the more difficult is the scheduling
- Scheduling authorities themselves have limited time and varying degrees of commitment to supporting contractors, which can lead to less-than-ideal assignment of SMEs

5.2.2 The Need For SMEs

There are a variety of instances in which a contractor would require the services of SMEs. They may be required to participate in practical studies in trainers or at sea, to explain particular processes such as the picture compilation process or the Detect-to-Engage sequence, as interviewees or focus group members for Cognitive Task Analyses or team function analyses, to provide estimates of task outcomes for modelling applications, or as advisors during any part of the design cycle to name but a few. Different applications imply different needs in terms of duration, number of cycles for an individual SME or groups of SMEs, number of similar SMEs for an individual cycle etc.

5.3 Potential Approaches

Accepting that SME support to contractors will continue to be a requirement, it could be helpful to consider the various means by which this could be accomplished. Options include:

- Current structure
- Centralized SME availability pool
- Serving SMEs attached to a project
- Serving SMEs paid in their off time as consultants
- Independent SME pool of Navy retirees
- Hybrid approach

5.3.1 Current Structure

Usually the contractor identifies the requirement for SME support and advises the Scientific Authority (SA). The SA will contact the Naval Liaison Officer (NLO) at the appropriate DRDC

establishment and request that the NLO make arrangements for the SMEs identified by the contractor. Depending on the NLO's particular background he/she will contact a variety of sources to request the SMEs. These sources might be Formation personnel pools, operational ships, training establishments or a variety of other sources. The level of effort increases significantly as the number of SMEs or the duration of the commitment increases.

Advantages of the Current Structure:

- The supplied SMEs will normally incur no additional costs to the Navy or the project
- The SMEs that meet the qualifications defined by the contractor are representational of their peer group and are normally very helpful
- SMEs generally already have the appropriate security clearance when one is required

Disadvantages of the Current Structure:

- A long lead time is required to identify available SMEs
- This long lead time leaves little or no flexibility to deal with schedule changes arising for unrelated reasons
- The NLO's task can be very challenging and time consuming
- The supplied SMEs often do not meet the qualifications defined by the contractor for a variety of reasons
- The supplied SMEs will almost always be unfamiliar with the project so will need to be initiated, which results in either increased availability requirements or reduced employment availability
- Supplied SMEs are taken away from pressing duties

5.3.2 Centralized SME Availability Pool

This pool would exist as a list of all available SMEs in a particular geographical area by qualification and availability dates at least, and perhaps other criteria. A NLO or other scheduling authority need only consult the pool and contact the units of identified SMEs to confirm availability.

Advantages of a Centralized SME Availability Pool:

- Near instantaneous confirmation or disconfirmation of available qualified SMEs for the requested period
- Ease of information sourcing from the NLO or scheduling authority perspective would add a degree of flexibility to the project schedule
- SMEs generally already have the appropriate security clearance when one is required
- The supplied SMEs will normally incur no additional costs to the Navy or the project

Disadvantages of a Centralized SME Availability Pool:

- A significant additional administrative workload on the unit to identify and report personnel availability in detail. This would probably result in reluctance to participate and might require an order, perhaps from even the Formation Commander.
- While the list may be accurate in the short term, it would get increasingly inaccurate the farther in advance one was planning
- Knowing that personnel identified on the list would be vulnerable to be called into service and thus lost to the unit, the unit may tend to send personnel of less capability to the pool, thus making it non-representational of the Navy at large.

5.3.3 Serving SMEs Attached to a Project

This approach would involve assigning serving naval personnel as a resource to a project once they have been identified as being qualified and available. These personnel would remain with their unit but be made available for hours or at most a few days at a time when required to support the project. If they were posted, then either the responsibility would continue, or they could be made responsible for identifying and briefing a successor.

Advantages of Having Serving SMEs Attached to a Project:

- The process of identifying available, suitably qualified SMEs need only be undertaken once for projects with multiple needs for the same SME skill sets
- The SMEs would become familiar with the contractor and the requirements of the project, resulting in reduced orientation requirements and increased time efficiency
- The communication channels between contractors and SMEs would be significantly simplified, easily facilitating frequent, brief interaction when required
- The SMEs would acquire an understanding of work being done outside the purview of their immediate duties
- SMEs generally already have the appropriate security clearance when one is required
- The supplied SMEs will normally incur no additional costs to the Navy or the project

Disadvantages of Having Serving SMEs Attached to a Project:

- It may be difficult initially to identify suitable SMEs that would be available for the duration of the project
- The cumulative time demands on the SMEs may conflict with their primary duties, meaning one or the other has to give
- Posting cycles or deployment schedules may interfere with availability of assigned SMEs
- This approach would be unsuitable for projects that by their nature require short-term support from a wide variety of different SMEs or for many SMEs from one category.

5.3.4 Serving SMEs Paid in their Off Time as Consultants

This approach would involve serving SMEs being paid through the project for work they do on their own time, whether that be evenings, weekends or statutory holidays, or annual or unpaid leave periods. They would be paid on an hourly basis at some agreed rate.

Advantages of Using Serving SMEs Paid in their Off Time as Consultants:

- Neither SMEs nor their units would loose productivity during normal working hours
- SMEs would be more available because the consultant would not be competing for scarce availability during normal working hours
- NLOs or scheduling authorities need only identify potential candidates; it would be up to the contractor and the SMEs to come to terms on arrangements on a non-interference basis with the Navy
- The contractor would be more likely to get the SMEs best suited to the requirements of the project
- SMEs generally already have the appropriate security clearance when one is required

Disadvantages of Using Serving SMEs Paid in their Off Time as Consultants:

- Conflicts may arise when the SME support must be during normal working hours; the SME would have to ask for leave or time off from the unit
- Posting cycles or deployment schedules may interfere with the availability of identified SMEs
- The degree to which this idea is contrary to existing DND policies is unknown
- DND is essentially paying for their own expertise
- This approach could be perceived by the Navy as facilitating the recruitment of experienced personnel away from the Navy into a contractor's organization

5.3.5 Independent SME Pool of Navy Retirees

This pool of experts would be called upon as paid consultants on an as-required basis. They may be fully retired or engaged in a second career, and would generally work on an ad-hoc basis. The size and composition of the pool would vary with time depending on projected requirements and the success of attracting suitable candidates to the pool.

Advantages of an Independent Pool of Navy Retirees:

- The effort required to establish and maintain the pool would be totally independent of Navy resources
- Contractors would have the freedom to select only suitable SMEs into the pool, and then to select which ones best meet the requirements for any given project
- A well established pool would provide the contractor with the flexibility required to react to short notice schedule changes or opportunities to access high demand resources such as naval trainers
- The pool could readily be used for support during stages of a project when the participation of SMEs with extremely current or very specific experience is not critical

Disadvantages of an Independent Pool of Navy Retirees:

- It could take considerable effort to find SMEs with the required qualifications, experience and currency, and who are available for part-time, ad-hoc work
- Security clearances for the pool members would become the responsibility of the maintaining agency

- The overall maintenance of the pool would represent a cost to the maintaining agency that would have to borne either by that agency or by DND
- There would have to be regular scheduled turnover within the pool as retirees skill sets and familiarity with up to date practises would deteriorate over time
- There would be increased administration to have the list of potential SMEs for a given project added to the bid or contract
- There would be a cost to DND for the provision of the SME services

5.3.6 Hybrid Approach

There are significant advantages and disadvantages to all of the approaches discussed above. There may in fact be no requirement to choose one over another; with the concurrence of the appropriate authorities an approach could be adopted that leverages the advantages of the various options while minimizing the disadvantages. In this way, a variety of mechanisms for acquiring the appropriate SME support for any given project could be used depending on the specific natures of the project and of the SME support required.

Advantages of a Hybrid Approach:

- The majority of support required for a project would be identified up front, resulting in an understanding by all stakeholders of the scope of the support
- The various components of the support required could readily be associated with the most effective means of providing that support
- Trade offs can be made among stakeholders to arrive at a compromise between administrative requirements to arrange support on a case by case basis, the requirement to pull operational personnel from their regular duties, and cost to DND to provide contracted support
- The support ultimately provided to the contractor would be more suited to the requirements with a reduction on the overall administrative load of the Navy

Disadvantages of a Hybrid Approach:

- Because several of the available options involve contracting SMEs, there would be a cost to DND
- Policies to facilitate some of the options would have to be researched to ensure they exist, or, if they do not, policies would have to be drawn up and approved

5.4 Recommended Approach

While there is no obvious single best option, to effectively support contractor requirements, we recommend a hybrid approach consisting of elements of the current system (2.1), attaching serving SMEs to a project (2.3), and paying serving SMEs in their off time as consultants (2.4).

The idea of a centralized SME pool (2.2) was ruled out because the administrative demands on the Navy to effectively manage the pool would outweigh the benefits of the ready availability of SMEs. Likewise, the idea of an independent SME pool of retirees (2.5) was ruled out because of the excessive effort required on the part of the contractor to build and maintain the pool. The overhead of recruiting and administration for people infrequently called upon would have to be

passed on to DND in order to make this a viable option for the contractor, likely resulting in inordinately high costs to DND.

For contractors to fulfil the mandate given them with respect to SME input for a DND contract, a balance has to be reached among three competing components. These components are:

- first, the SME input required to provide valid and accurate information for the study,
- second, the demands on Navy resources to arrange for and deliver suitable SMEs and
- third, the end cost to DND for the support.

The recommended approach would build on the current system of providing support as opposed to replacing it. Recognizing that each project will have its own unique support requirements, having the flexibility to arrange for one or more particularly valuable SMEs to be attached as support to the project on an as-needed basis, or to pay serving SMEs on a short term, ad hoc basis for specific support requirements would go a long way to effectively meeting the balance among the competing requirements. Although the approach of paying serving SMEs in their off time would admittedly add expense to the project, the benefits of ensuring the right support is available at the critical time outweigh the costs when the overall risk to the project is considered.

The major challenges to achieving this would include:

For attaching serving personnel to a project:

- For this to be successful either individual unit commanders would have to agree to allow personnel under their command to participate, or a higher authority (CMS, Formation Commander or MAROPSGRU Commander) would have to put in place a policy whereby units commanders were required to cooperate to the extent possible given current demands on their personnel. The former would likely require a significant investment of effort on the part of an NLO to negotiate with commanders on a case-by-case basis. The latter would likely take a significant one time investment of time by DRDC to convince a higher authority of the value of this approach

For paying serving SMEs in their off time as consultants:

- If there was a large volume of work assigned to individuals and paid by contractors, suitable SMEs might have to invest the time and effort to set themselves up as self-employed consultants. This could include registering themselves as a business and maintaining all required paperwork, including GST management. We believe the annual threshold is $30k, and that this is unlikely to be reached in the great majority of cases. An alternative might be to make payments through navy pay channels.
- Currently there appear to be barriers within DND to having SMEs work as paid consultants on DND business. While any cultural barriers could be overcome with time, any administrative/policy barriers impeding the lawful employment of currently serving SMEs would have to be addressed up front. This would likely take a significant one-time investment of time by DRDC to achieve.

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6. Overall Summary

This body of work analyses the suitability and practicality of using the ORTT Navy training records as an alternative to NCOT for the collection of COMDAT TD relevant MOPs. An analysis methodology was developed for the extraction of MOP data, and a range of suitable MOPs was demonstrated as being practically accessible from the data record. It was concluded that the ORTT scenario records would be more suitable to collect MOP data than conducting a dedicated T&E trial in NCOT. Finally, a recommended approach was described by which the Navy can provide SMEs to support future R&D efforts, without incurring an unacceptable administrative and manpower burden.

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7. List of Acronyms

AAWC	Anti Air Warfare Commander
ALG	Algonquin
AOP	Area of Probability
ARRO	Air Raid Reporting Operator (formerly RT1)
AS	Anti Surface Warfare Commander (Also ASuWC)
ASPO	Anti-submarine Plotting Operator (formerly RT2)
ASuWC	Anti Surface Warfare Commander (Also AS)
ASWC	Anti Submarine Warfare Commander
ASWD	Anti Submarine Warfare Director
AX	Anti Submarine Warfare Commander
CAP	Combat Air Patrol
CO	Commanding Officer
CCS	Command and Control System
CSTC	Combat Systems Training Centre
CTA	Cognitive Task Analysis
CTG	Commander Task Group
C&C	Command and Control
C2	Command and Control
ESM	Electronic Support Measure
EWS	Electronic Warfare Supervisor
FCS	Fire Control Supervisor
HAL	Halifax
Helo	Helicopter
MOP(s)	Measure(s) of Performance
MPA	Maritime Patrol Aircraft
MSDF	Multi Sensor Data Fusion
NCOT	Naval Combat Operator Trainer
OOW	Officer of the Watch
ORO	Operations Room Officer
ORTT	Operations Room Team Trainer
POC	Proof of Concept
PU	Participating Unit
REG	Regina
ROE	Rules of Engagement
SAC	Ship-borne Air Controller
SAG	Surface Action Group
SCS	Sonar Control Supervisor
SITREP	Situation Report
SME	Subject Matter Expert
SWC	Sensor Weapons Controller
TG	Task Group
T&E	Test & Evaluation
VAN	Vancouver

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Annex A: Ability of the ORTT to support T&E MOPs

Specific problems in collecting/conducting MOPs are emphasised in bold text. Numbers refer to MOP labels in prior reports

DETAILED MEASURES	FEASIBILITY IN ORTT / COMMENTS
T&E TASK 1 Check mission picture 2.1.1	
1a Accuracy in detecting relevant info within incoming message stream	Can get information from audio playback and real-time scenario monitoring Messages passed by hand (non-scripted) can't get from digital record obtainable through real-time monitoring (make note of content and when passed) and video record for time of occurrence. Amount of paper messages here is 1% of real-life Can send text messages to signalman through CCS, but not used often
1b Accuracy in ignoring irrelevant info	**N/A in ORTT b/c no irrelevant info inputted**
1c Total time spent in comms dealing with incoming info	Could get from audio track and video; labour intensive
1d Time to detect high salience message	Voice message – observe acknowledgement or operator action by way of video playback or real-time monitoring
1e Accuracy in requesting additional info (i.e. number of messages that required follow up that resulted in ORO request for more info)	Possibly– we don't have the control needed (may do ad-hoc)
1f Accuracy in ignoring lower priority messages	**No** – not done in training scenario (only at sea) - may happen by chance
T&E TASK 2. Relate new info Ops Room picture 2.1.2	
2a Accuracy in directing (communicates) info/direction resulting from message	Can get from video, audio, rely on SME to determine if correct
2b Accuracy re message content in briefing appropriate stn	Same as 2a.
2c Accuracy in comprehension of impact on pre-plans/response options/tactical situation	Can do in ORTT; team must be put under conflict then ORO must make decision
2d Accuracy in recognition of impact on Ops Room capability	Can simulate this in ORTT 2 if the team is getting good, game controllers may input equipment malfunctions, etc. but not likely
2e Total time spent in relaying info re Ops Room status	
T&E TASK 3 Relate (new info) to RMP Includes aspects of build awareness across domains (RAP, MSP, MsubP).	
3a Accuracy of salient info within RMP *prior* to new message	**N/A b/c can't do probes**; can only infer knowledge of ORO from comms, may get through team briefing? (high level briefings, not done regularly). Maybe we can use tags?
3b Accuracy of salient info within RMP *after* new message	**same as 3a**
3c Time for ORO to complete understanding of new info regarding RMP	**same as 3a**
3d Accuracy in taking appropriate action as a result of updated RMP	**same as 3a.** Ample salient info presented to ORO. Master Events List will be helpful. CFNOS testing criteria/scoring sheets & would it be helpful
3e Total time spent on SSD relating new info to RMP	May be complex to assemble.
3f Accuracy in assessing the integrated tactical picture	Can get from multiple threats and threat priorities; can't control the scenario but can infer from SME assessment of scenario playback (comms and video)

DETAILED MEASURES	FEASIBILITY IN ORTT / COMMENTS
T&E TASK 4 Relate new info to RAP 2.1.5. (as an example): Ensure contact classified 2.4.3.1 Note: Same approach/measures to be used in principle for MSP and MsubP	
SUB TASK 4.1 Identify friendly aircraft Few, if any occurrences in ORTT scenario.	
4.1a Accuracy in identifying friendly aircraft (by type/mission)	Available from scenario ground truth. May assess at RT1 level.
4.1b Mean time spent in identifying friendly aircraft	See 4.1a
4.1c Total number of queries or total time spent in querying team for additional info	See 4.1a
SUB TASK 4.2 Identify hostile/suspect aircraft Hostile / suspect a/c will be occasional insertions in main air contact data stream.	
4.2a Accuracy in identifying hostile / suspect aircraft (by aircraft type)	Can do if we have ground truth
4.2b Mean time spent in identifying hostile/suspect aircraft	Can get; beginning time is when track first initiated by ATAI (auto track, auto initiate) if we know ground truth
4.2c Total number of queries or total time spent in querying team for additional info	Can get from playback
SUB TASK 4.3 Identify neutral aircraft	
4.3a Accuracy in identifying neutral aircraft	Same as 4.2; neutral = "non-threat", military unit; if not put in game, can probably ask for one
4.3b Total time spent in identifying neutral aircraft	Same as 4.2
4.3c Total number of queries or total time spent in querying team for additional info	Same as 4.2
SUB TASK 4.4 Identify NU tracks (non-updated)	
4.4a Accuracy in identifying NU tracks	**Not normally included in scenario in ORTT** (NU track is when track quality deteriorates to 1; when it starts flashing = NU. Normally associated with link)
4.4b Total time spent in identifying NU tracks	Same as 4.4a
4.4c Total number of queries or total time spent in querying team for additional info	Same as 4.4a
SUB TASK 4.5 Identify tracks reported by ownship or, conversely, by other participating units (Pus)	
4.5a Accuracy identifying air tracks being reported by ownship	Not a relevant measure
4.5b Total time spent locating air tracks being reported by ownship	Not a relevant measure
4.5c Total number of queries or total time spent in querying team for additional info	Not a relevant measure
SUB TASK 4.6 Identify own force engagement status This measure will only be used if scenario requires engagement	
4.6a Accuracy identifying air tracks being engaged by ownship or ships in TG	**Needs a T&E probe-probably not available**
4.6b Total time spent in locating air tracks being engaged	Should be: "response time to be ready to engage correct track" b/c may purposely decide to wait to engage. This could be a measure for SWC or ORO
4.6c Total number of queries or total time spent in querying team for additional info	Should be: "total time querying team for info (not "additional info") Can get from comm playback
SUB TASK 4.7 React to threat track symbology LINKed by consort not on video	
4.7a Time to recognise symbology not on video	**N/A in ORTT**
4.7b Time to order remedial action	**N/A in ORTT**
SUB TASK 4.8 React to LINK not gridlocked	
4.8a Time to recognise LINK not gridlocked	**N/A in ORTT**
4.8b Time to order remedial action	**N/A in ORTT**

DETAILED MEASURES	FEASIBILITY IN ORTT / COMMENTS
T&E TASK 7 Assess threats -generic	
SUB TASK 7.1 Detect changes in tactical situation	
7.1a Accuracy in ID new threats	Can easily get accuracy and ID. Lots of threats in scenario.
7.1b Accuracy in ID changes in threat status	Lots of opportunity provided in scenarios for misidentifications
7.1c Time to detect new threat	Should be: "time to ID new threat". Easily achieved from playback if flag assigned by T&E team during scenario execution Not ORO measure; more a team or even task group measure.
7.1d Time to detect change in threat status	Same as 7.1c
7.1e Time to provide SITREP	Maybe ad-hoc but difficult to plan/guarantee in ORTT May be able to ask trainer to ask for ORO sitrep
7.1f. Accuracy in SITREP contents	same as 7.1e; decompose after and get ground truth
SUB TASK 7.2 Determine threat priorities across domains Will need to vary circumstances to ensure that some threat changes occur in a particular domain while the focus is in that domain, at other times when focus is in another domain	
7.2a Accuracy in ranking threat priorities across domains	Likely not feasible in ORTT We know ground truth but don't know what team knows; need to infer accuracy based on what team knows. May use SME assessment of team behaviour.
7.2b Time to assess threat priorities across domains	May be feasible from determining onset time of threats and orders to team.
SUB TASK 7.3 Assess threats- (air warfare specific) Identify air track threat priority Similar MOPs should apply in principle to other warfare areas.	
7.3a Accuracy in identifying threat priorities	Done by RT1 as part of resolve procedure.
7.3b Total time to identify three highest priority threats	**N/A**; perhaps time to resolve is better measure?
7.3c Time to annotate CCS with CPA	**N/A**; perhaps time to resolve is better measure? Should be able to identify when it is resolved (i.e. endpoint); maybe when resolved on SSD (identifying track).
7.3d Accuracy in determining CPA	**N/A**; perhaps time to resolve is better measure?
7.3e Accuracy in determining lethality	Not relevant; related to threat priority
7.3f Time to determine lethality	Same as 7.3e
7.3g Time to create a SITREP	**Cannot insert T&E requirement for SITREP: may need to rely on when CO asks for one**
7.3h Accuracy and completeness of SITREP	**As for 7.3g**
SUB TASK 7.4 Analyse history profile[13] of hostile aircraft	
7.4a Accuracy in analysing attack history of hostile aircraft	**Not relevant; no repeated action in scenarios**
7.4b Time to analyse attack history of hostile aircraft	**Not relevant; no repeated action in scenarios**
7.4c Accuracy in assessing number of weapons remaining on hostile aircraft	Determine from ORO/SWC comms
7.4d Total number of queries or total time spent in querying team for additional info	Same as 7.4c
7.4e Accuracy in assessing attack tactics used by hostile aircraft (individual contacts)	**Not relevant**

[13] By history profile we mean the patterns of trajectory shown over time by a particular contact that is potentially hostile; these patterns include changes in altitude, speed and direction, communication trends, EW emissions etc.

DETAILED MEASURES	FEASIBILITY IN ORTT / COMMENTS
T&E TASK 9 **Assess sensors:** Sensor information can become degraded through equipment malfunctions or restrictions. Hence, will need to ensure that sensor becomes degraded during scenario	
9a Accuracy assessing that sensors are less than optimum	**Not feasible in existing scenarios**
9b Time to appreciate sensor performing less than optimum	**Not feasible in existing scenarios**
9c Accuracy in identifying current sensor range predictions	**Not feasible in existing scenarios**
9d Total time in identifying current sensor range predictions	**Not feasible in existing scenarios**
T&E TASK 10 Manage ship surveillance	
10a Accuracy recognising problems in detect to resolve process	SME reviews ORO actions in replay
10b Time to recognise problems in detect-to-resolve process	Can determine from micro analysis of replay
10c Appropriateness of remedial action to correct errors	SME reviews ORO actions in replay

Table A1: Summary of feasibility of collecting MOP data in the ORTT

Annex B: Feasibility and methods for providing information to ORO and for capturing MOPs

Means of providing info to ORO (other than T&E software)	Feasible	Timing Sent	Timing Recd	T&E - who does?	If not T&E, ID source	Capture Response Action	Capture Response Content	ID target of response	Time of response	Assess Response
Text message via CCS	NO									
Text message by hand	YES: real-time observation or video record	YES: need to add flag to T&E video record	YES: obs notes	ORO obs, trial coord from video record		YES: real-time observation or scenario playback	YES: real-time observation or scenario playback	YES: real-time observation or scenario playback	YES: from scenario playback clock or obs record	Post event analysis by SME
Voice message from net	YES playback of comm record	YES Playback clock:	YES: playback clock	Not required	YES: video/audio record	YES: ORTT video/audio record of ORO	YES: ORTT video/audio record of ORO	YES: ORTT video/audio record of ORO	YES: from scenario playback clock or obs record	Post event analysis by SME
Voice message face to face	YES: from T&E video/audio record or real-time obs	YES: need to add clock to T&E video record	YES:	Not required	YES: video/audio record	YES: ORTT video/audio record of ORO or scenario playback	YES: ORTT video/audio record of ORO or scenario playback	YES: ORTT video/audio record of ORO or scenario playback	YES: from scenario playback clock or obs record.	Post event analysis by SME

Table B1: Methods assessed in ORTT for capturing data for MOPs

Input events from scenario	Time into scenario	Time painted	Time into AOI	Time symbology	Time Out	Time change in status	Time at own ship weapons range	Time at A/C weapons range	Time EWS emitted	Time EWS detected
Background air/surface-commercial Background surface Hostile air Hostile surface A/C changes course to TG A/C changes speed A/C changes alt A/C radar A/C changes previous pattern A/C assumes attack profile Neutral-changes profile ASCACT patterns	Dependent on scenario May be able to get Master Events List from trainers. T&E personnel insert flags during scenario execution.	YES: master events list provided by trainer or scenario playback. T&E personnel insert flags during scenario execution.	YES: scenario playback and observing appropriate SSD T&E personnel insert flags during scenario execution.	YES: from scenario playback T&E personnel insert flags during scenario execution.	YES: scenario playback T&E personnel insert flags during scenario execution.	YES: master events list provided by trainer or scenario playback T&E personnel insert flags during scenario execution.	YES: scenario playback	YES: scenario playback	YES: from master events list provided by trainer or scenario playback	YES: scenario playback

ORO actions	**Scenario playback** **Audio/video record**	**Scenario playback** **Time stamped audio/video record**	
ORO action on CCS	YES. Scenario playback	YES: Scenario playback	
ORO consults other sources		ORO use of ancillary information (e.g. manuals, plot, simulated stateboards, tacpacs) captured by ancillary video and analysed post event. May also be captured by direct ORO observation.	

Table B2: Scenario events and ORO actions assessed for capturing MOP data

ORO Communications	Capture message content		Capture/ timestamp action		ID recipient	Assess content
ORO speaks directly to team/member (not on net)	YES: separate audio/video record		YES. separate audio/video record.		YES. Separate audio/video record	SME analysis of audio/video record
ORO uses net	YES: ORTT audio record		YES: ORTT audio playback plus CCS clock		YES: playback of audio circuit	SME analysis of T&E audio playback
Assessing ORO knowledge	**Real time SITREP to CO** ***Only achievable if CO requests***	**ORO CCS Display**	**Bogus request for info**	**Response time to embedded probe**		
Picture content at start of scenario	YES: link audio file with scenario playback - depends	YES: scenario playback	**NO**	**NO**		
Change in picture content	YES: scenario playback	YES: scenario playback	YES: scenario playback	YES: scenario playback		
Indiv threat comprehension	YES: scenario playback	YES: scenario playback	YES: scenario playback	NA		
Change in threat status	YES: scenario playback	YES: scenario playback	YES: scenario playback	YES: scenario playback		
Relative threat priorities	YES: scenario playback	YES: scenario playback	YES: scenario playback			
Tactical situation	YES: scenario playback		YES: scenario playback			
Time to CPA	YES: scenario playback	YES: scenario playback	YES: scenario playback			
Own engagement envelope: earliest/latest point to shoot -		YES: scenario playback				
Enemy engagement range –contact		YES: scenario playback				

Table B2: Scenario events and ORO actions assessed for capturing MOP data (continued)

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Annex C: Scenario data record

C-1: Data record for selected air, subsurface and surface tracks

			ORO		SWC		ARRO		CANEWS		ASWC	
Time	Events	Comments	Send	Receive	Send	Receive	Send	Receive	Send	Receive	Send	Receive
9:18:40	Air Track 2400 appears, this is a new, unassessed air track											
9:18:44	ORO hooks Track2400											
9:18:54					AWW I net / to team - resolve 2400							
9:19:03	No IFF implies non-commercial						AWWI: course, speed & neg IFF					
9:19:07									AWWI: Neg ESM			
9:19:09	2400 made suspect by RT1	Adds to suspicion			AWWI: issue warning 1 to suspect 2400							
9:20:14	ORO adjusts rangescale to 128 and hooks Track2400											
9:21:40			C&C -ORO asks SWC if there might be any surface contacts that 2400 might be passing targeting info to. SWC apparently misinterprets the question and responds that he agrees that 2400 is probably an			C&C -ORO asks SWC if there might be any surface contacts that 2400 might be passing targeting info to. SWC apparently misinterprets the question and responds that he agrees that 2400 is probably an						

			ORO		SWC		ARRO		CANEWS		ASWC	
Time	Events	Comments	Send	Receive	Send	Receive	Send	Receive	Send	Receive	Send	Receive
			MPA			MPA						
9:22:43	ORO informed that warning 3 being issued to Track2400	Miscommuni cation between ORO & SWC about what 2400 is		C&C - SWC to ORO - update that AAWC issuing Warning 3 to suspect 2400	C&C - SWC to ORO - update that AAWC issuing Warning 3 to suspect 2400							
9:23:04	New air Track2404 on Link from REG; RT1 hooks Track2404											
9:23:08	SPS 49 radar generated local air track 8011 in commercial air lane	only RT1 knows it exists based on his range scale										
9:23:16	HAL manually put in altitude and speed after conversation with REG on AAW Coord external	new air track in commercial air lane										
9:23:30	REG released track to link before HAL released track to link, therefore local and remote tracks superimposed; required manual intervention by RT1 to correlate											
9:23:30	SWC has altitude & new speed on Track2404; reporting unit is REG.	both local and link track numbers are showing on CCS screen for this air contact; clutters display										
9:24:04	RT1 made 2404 assumed friend based on speed and air lane even though no IFF											
9:24:30	SWC informs ORO that they've been directed to re-issue	air Track2404 made		C&C - SWC jumps to C&C to brief	C&C - SWC jumps to C&C to brief							

			ORO		SWC		ARRO		CANEWS		ASWC	
Time	**Events**	**Comments**	**Send**	**Receive**	**Send**	**Receive**	**Send**	**Receive**	**Send**	**Receive**	**Send**	**Receive**
	Warning 2 to Track2400	assumed friend even though no IFF information		ORO that they've been directed to re-issue Warning 2 to 2400	ORO that they've been directed to re-issue Warning 2 to 2400							
9:27:08	EWS told SWC that air Track2400 is Mainstay aircraft based on EWS information					AWW I - EWS to SWC reporting rkt 2217 and correlated with 2400 and concluded carried on Mainstay aircraft (so know type of aircraft)			AWW I - EWS to SWC reporting rkt 2217 and correlated with 2400 and concluded carried on Mainstay aircraft (so know type of aircraft)			
9:28:04	ORO hooked air Track 2400											
9:29:08	REG reporting Track2400 is hostile; ORO on HAL recommends Track2400 be made hostile		C&C - ORO recommended air Track 2400 (assessed Mainstay) be made hostile									
9:35:20	AAW Coord external - HAL to AAWC - recommend have 2 friendlies (suspect CAP) and sending them over to kill Track2400	ORO tells team to make air Track2400 hostile based on REG reporting Track2400 is hostile										

			ORO		SWC		ARRO		CANEWS		ASWC	
Time	Events	Comments	Send	Receive	Send	Receive	Send	Receive	Send	Receive	Send	Receive
9:59:55	HAL sonar (HMS) picked up sub surface contact 3 NM from HAL	HAL recommending to Anti-air Warfare Commander of Task Group to have 2 friendly aircraft kill hostile Track2400									ASW External (Action A net) - HAL ASWC reported "hot"/sonar contact 3 NM from HAL	
10:00:05	HAL conducted urgent torpedo attack on new sonar contact, Poss sub 2275	HAL hull-mounted sonar pickup sub-surface contact 3 nautical miles away									ASW External - HAL ASWC reported that HAL conducted urgent torpedo attack on Poss sub 2275 (classified poss sub low 2)	
10:00:34	actual firing and proper external report by HAL ASWC (no consideration for fact that ASW weapons are tight)	sub-surface contact assess as possible sub and identified as Track2275; HAL launches torpedo at it to see if it moves like a sub										

			ORO		SWC		ARRO		CANEWS		ASWC	
Time	**Events**	**Comments**	**Send**	**Receive**	**Send**	**Receive**	**Send**	**Receive**	**Send**	**Receive**	**Send**	**Receive**
10:01:28		ASWC properly announcing torpedo fire. Does not consider that "weapons tight" (can only fire on contact positively ID'd as hostile)										
10:02:42	HAL reassessed 2275 as poss sub low 2											
10:15:14	new underwater contact Track2463 appears on Link from REG	sub-surface Track2275 classified as poss sub low 2										
10:15:17		new underwater contact picked up by REG and put on Link										
10:15:20											ASW External - ASWC asked RT2 about 2463	
10:16:05	REG reported conducted urgent torpedo attack on track 2463, assessed Akula class sub	REG assess Track2463 as Akula class sub										
10:16:20	D9L (HAL CH124-B) on top Hostile 2275 and didn't report Madman	HAL helicopter reported that they didn't see metal when they flew over hostile Track2275										
10:16:30	Track2463 made Hostile by REG; classified as Poss sub low 1	REG assessed Track2463 as hostile										

			ORO		SWC		ARRO		CANEWS		ASWC	
Time	**Events**	**Comments**	**Send**	**Receive**	**Send**	**Receive**	**Send**	**Receive**	**Send**	**Receive**	**Send**	**Receive**
		and classified it as poss sub low 1										
10:16:45	REG holding blade (hear props) on Hostile 2463	REG reports that hear props from hostile Track2463, confirming it's a sub										
10:16:49	torpedo bearing line 2463 appeared on RT2 screen (detected by REG & sent on link)	REG inputs torpedo bearing line and sends on Link										
10:17:10		ASWC gives ORO situation report on status of Track2463 and Track2275	C&C - ORO & ASWC sitrep regarding 2463 and 2275									
10:18:18	REG reassessed Track2463 from Poss sub low 1 to Prob sub based on torpedo	REG more confident that Track2463 is a sub based on its actions following torpedo fire										
10:18:20	new surface Track7610 appears on SWC screen											
10:18:30	HAL helo reported Madman when on top hostile 2467 (*formerly 2463 - b/w 10:17:14 & 10:18:45 track # changed)	HAL helicopter reported that they saw metal when flying over Track2467 (formerly 2463)										
10:18:55	HAL assessed hostile 2275 as decoy;	HAL concluded										

			ORO		SWC		ARRO		CANEWS		ASWC	
Time	Events	Comments	Send	Receive	Send	Receive	Send	Receive	Send	Receive	Send	Receive
	"correlated 2467 with 2275"; taken 2275 off link	Track2275 is a decoy and Track2467 is the real hostile sub										
10:18:55	recommendation to make 7610 suspect poss Delhi based on proximity to downed aircraft (CAP sent to shoot down Mainstay) and proximity to unassociated ESM (7600)	recommend Track7610 is possible Delhi (Indian warship) based on proximity relative to Mainstay aircraft shot down (Track2400)										
10:19:00	surface track 7610 made suspect											
10:19:24	track 2467 reassigned as 2275; in place of former 2275 put in new hostile non-sub 2310	Poor picture/track management by HAL (and the ASW Commander who is control staff so not surprising here)										
10:19:45	RT2 amplified decoy											
10:23:50	MPA associated racket 7600 with suspect 7610											
10:24:30	Recommend make 7610 Suspect based on proximity to SAG AOP	recommended that Track7610 be made suspect based on proximity to downed aircraft										
10:25:20	REG: make 7610 Hostile based on assoc with ESM, prox to AOP for downed a/c and behaviour.	REG makes Track7610 hostile based on ESM info and										

			ORO		SWC		ARRO		CANEWS		ASWC	
Time	**Events**	**Comments**	**Send**	**Receive**	**Send**	**Receive**	**Send**	**Receive**	**Send**	**Receive**	**Send**	**Receive**
	VAN (control staff) agreed with REG	proximity to downed aircraft										
10:26	VAN rec to AS - Hostile 7610 outside weapons range therefore no warnings to be issued by MPA	VAN states that Track7610 is outside weapons range so no warnings will be used by Maritime Patrol Aircraft										

Annex D: Elements of an Independent SME Pool of Naval Retirees for the COMDAT Project

This Annex identifies the recommended composition of an independent SME pool, if one were to be considered, using the example of the COMDAT project. The approach taken was to identify the relevant operational functions within the operations sub-teams that would apply to the project, and then determine whether that function could be simulated by a generic naval SME with verbal input to the team, or would require a qualified operator to fulfil the requirements of the function. The SME pool would be comprised of representatives from the positions that were required to support data collection scenarios and whose functions could not be simulated, as well as the generic naval SME.

The functions include:

- Radar tracking/above water picture compilation
- Underwater picture compilation
- Electronic support measures (ESM)
- Fire control
- Aircraft control
- Warfare sub-team direction
- Ops room direction
- Command

Function: Radar Tracking/Above Water Picture Compilation

- Related positions:
  - Track Supervisor (TS).
  - Air Raid Reporting Operator (ARRO).

- MOC / qualification / rank / experience:
  MOC: Naval Combat Information Operator (NCIOP). The TS is normally a QL5. The ARRO has a billeted position of a QL3 but is often a QL4 or QL5 in practise. Expected ranks would range from Ordinary Seaman (OS) to Master Seaman (MS), with one to eight years experience.

- Responsibilities:
  Radar detection and tracking, above water picture compilation including surface and air, physical control of the SPS 49 air search radar and SG 150 multi-purpose radar, and link management.

- Criticality:
  - TS is a critical role in the ops team and required in nearly every conceivable scenario.
  - ARRO is a critical role in the Anti Air Warfare (AAW) sub-team and required for any AAW scenario.
  - Very difficult if not impossible to simulate the functions of these two operators.

- Availability
  Experienced SMEs to fill this position are likely fairly readily available from within navy resources. Retired SMEs are likely to be available in the HFX area, but if they have a second career it may be difficult to ensure their availability on an ad hoc basis.

Under Water Picture Compilation

- Related positions:
  - Hull mounted sonar operator (HMS Operator)
  - Towed array sonar operators (CANTASS Operators)
  - Sonobuoy processing system operator (SPS Operator)
  - Sonar Control Supervisor (SCS)
  - Anti-submarine Plotting Operator (ASPO)

- MOC / qualification / rank / experience:
  MOC: Tactical Acoustic Sensor Operator (TASOP), except the ASPO who is NCIOP. The SCS is a QL6A. Other operators are QL3-5. The ASPO has a billeted position of a QL3 but is often a QL4 or QL5 in practise. Expected ranks would range from Ordinary Seaman (OS) to Petty Officer Second Class (PO2), with one to 14 years experience.

- Responsibilities:
  Underwater detection, tracking and localization, and input to the under water picture compilation process.

- Criticality:
  Most of the operator functions related to underwater detection are transparent and could easily be simulated. Even the role of the SCS could be simulated. However, the ASPO is a critical component of the ASW sub-team and would be required in any ASW scenario.

- Availability
  Experienced SMEs to fill this position are likely fairly readily available from within navy resources. Retired SMEs are likely to be available in the HFX area, but if they have a second career it may be difficult to ensure their availability on an ad hoc basis

Electronic Support Measures (ESM)

- Related positions:
  - Communications intercept operator (CIO Operator)
  - Canadian Electronic Warfare System operator (CANEWS Operator)
  - Electronic Warfare Supervisor (EWS)

- MOC / qualification / rank / experience:
  MOC: Naval Electronic Sensor Operator (NESOP). The EWS is a QL6A. Other operators are QL3-5. Expected ranks would range from Ordinary Seaman (OS) to Petty Officer Second Class (PO2), with one to 14 years experience.

- Responsibilities:
  Detection and assessment of voice and radar emissions, and input to the above water picture compilation process. The EWS also controls soft kill measures during ASMD.

- Criticality:
These functions are all important but input to the picture compilation process would be sporadic. The ASMD function is critical in real life but largely transparent during team training. It would be reasonably easy for a non-NESOP naval SME to simulate the ESM function at a basic level concurrent with other functions.

- Availability
Experienced SMEs to fill this position are likely fairly readily available from within navy resources. Retired SMEs are likely to be available in the HFX area, but if they have a second career it may be difficult to ensure their availability on an ad hoc basis

Fire Control (FC)

- Related positions:
- Fire control operators (FCO)
- Fire Control Supervisor (FCS)

- MOC / qualification / rank / experience:
MOC: Naval Electronic Sensor Operator (NESOP). The FCS is a QL5. The two operators are QL3-5. Expected ranks would range from Ordinary Seaman (OS) to Master Seaman (MS), with one to 10 years experience.

- Responsibilities:
Monitoring and reporting the status of the fire control radars and fire control solution throughout the designation to engage sequence. They may report the visual identification of an acquired target via the STIR cameras. They also control aspects of the 57 MM gun during an engagement.

- Criticality:
Much of the fire control function is redundant and can be performed by the SWC independently from the SWC console. The vast majority of verbal reports could be omitted during a simulation without seriously detracting from realism. Inputs such as the visual identity of a target could easily be simulated by anyone with or without naval experience.

- Availability
Experienced SMEs to fill this position are likely fairly readily available from within navy resources. Retired SMEs are likely to be available in the HFX area, but if they have a second career it may be difficult to ensure their availability on an ad hoc basis.

Aircraft Control

- Related positions:
- Shipborne air controller (SAC)

- MOC / qualification / rank / experience:
MOC: Naval Combat Information Operator (NCIOP) or Maritime Surface/Sub-surface Officer (MARS). The NCIOP is a QL5. The MARS officer is a “D” level qualified officer.

Expected ranks would be Leading/Master Seaman (LS/MS) or Sub-Lieutenant/Lieutenant (N). Each would have four to six years experience in the Navy.

- Responsibilities:
  Providing the interface between the ship, and helicopters and maritime patrol aircraft

- Criticality:
  The input they would provide to the picture compilation process would be relatively sporadic and could be simulated at a basic level by a non-SAC qualified naval SME.

- Availability
  Experienced SMEs to fill this position are likely fairly readily available from within navy resources. Retired SMEs are likely to be available in the HFX area, but if they have a second career it may be difficult to ensure their availability on an ad hoc basis.

Warfare Sub-team Direction

- Related positions:
  - Above Water Weapons Director (AWWD)
  - Anti-submarine Warfare Director (ASWD)

- MOC / qualification / rank / experience:
  MOC: NESOP, NACOP or MARS. The NESOP and NACOP are QL6B, and the MARS officer is a "D" level qualified officer. Expected ranks would be PO1 for the NESOP/NACOP, and Lt(N) for the officer. The NESOP/NACOP would have 12-15 years experience, and the officer five to eight years.

- Responsibilities:
  Sub-team supervision, picture compilation, threat assessment and weapons engagement of contacts in their particular warfare area

- Criticality:
  Both positions are critical for scenarios dealing with their domain, and they could not be simulated.

- Availability
  Experienced SMEs to fill this position are likely fairly readily available from within navy resources. Few SACs would retire from this position; more likely they carry on in their career and are somewhat dated by the time they retire. If they did retire from these positions they would likely have a second career it may be difficult to ensure their availability on an ad hoc basis.

Ops Room Direction

- Related positions:
  - Operations Room Officer (ORO)
  - Operations Room Supervisor (ORS)

- MOC / qualification / rank / experience:
  MOC: The ORO is MARS, ORO Course qualified. Expected ranks would be senior Lt(N) or junior LCdr, with eight to 12 years experience. The ORS is NCIOP, QL6A qualified. Expected rank would be PO2, with eight to 12 years experience.

- Responsibilities:
  The ORO is overall responsible for all activities within the ops room, which includes supervising and directing all aspects of picture compilation, threat assessment and weapons engagement. The directors and their teams are responsible to the ORO. The ORO provides the interface to the ship's captain. The ORS provides general supervision and coordination within the ops room, and interfaces with the Communications Control Room for communications needs.

- Criticality:
  The ORO is critical regardless of the scenario and could not be simulated. Although the ORS provides an important function at sea, it is largely in the background and this position is not critical to the picture compilation process.

- Availability
  Experienced SMEs to fill this position are likely fairly readily available from within navy resources. Few OROs and ORSs retire from this position; more likely they carry on in their career and are somewhat dated by the time they retire. If they did retire from these positions they would likely have a second career it may be difficult to ensure their availability on an ad hoc basis.

Command

- Related positions:
  - Commanding Officer (CO)
  - Executive Officer (XO)

- MOC / qualification / rank / experience:
  MOC: MARS, command qualified. Expected ranks would be senior LCdr to Capt(N), with 14-30 years experience.

- Responsibilities:
  Final supervision and authority of all activities of the ship. Sets or approves operational priorities. In a multi-threat situation, may directly participate in one threat area, delegating the other area to the ORO while demanding timely updates.

- Criticality:
  For complete reality, and particularly if assessing ORO roles, a command presence would be critical during scenarios involving engagements. For picture compilation processes, the role of command could be simulated by a suitable SME.

- Availability
  Experienced SMEs to fill this position are likely fairly readily available from within navy resources. Retired SMEs are likely to be available in the HFX area, but if they have a second career it may be difficult to ensure their availability on an ad hoc basis. It would

probably be easier to find retired COs willing to participate than some of the other positions.

Tabular Summary

The following table summarizes the recommended composition of an independent naval SME pool. The table indicates which elements could be simulated by a suitable generic naval SME who may fulfil the requirements of multiple elements simultaneously, and those elements that due to the nature of their required expertise or the scope of their role within the scenario, would have to be represented by SMEs with qualifications and experience in those positions.

Function	Required elements	Critical	Core/support	Pool element
Radar tracking/ AWW picture compilation	Track Sup	Y	Core	QL5/6A NCIOP
	ARRO	Y*	Core	QL5 NCIOP
Under water picture compilation	SCS	N	Support	Generic SME
	ASPO	Y*	Core	QL5 NCIOP
Electronic support measures	EWS	N	Support	Generic SME
Fire Control	FCO	N	Support	Generic SME
Aircraft control	SAC	N	Support	Generic SME
Warfare sub-team direction	AWWD	Y*	Core	QL6B NESOP Lt(N) director
	ASWD	Y*	Core	QL6B TASOP Lt(N) director
Ops room direction	ORS	N	Support	Generic SME
	ORO	Y	Core	ORO
Command	OOW	N	Support	Generic SME
	CO/XO	N	Support	Generic SME

* Dependent on focus of scenario

A core SME pool would consist of an ORO, an AWWD (either officer or NESOP), an ASWD (either officer or TASOP), a QL6A NCIOP, and one or two QL5 NCIOPs. In addition, at least one ORO would be required to fulfil the higher level requirements of a generic SME, and another SME, preferably an officer director, would be required to fulfil the other requirements. The pool would have to consist of multiple people for each element for scheduling redundancy. If a pool was intended to fulfil the requirements of multiple scenario runs with new players, then obviously the duplication of elements increases proportionately.

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14. ABSTRACT

(U) This report compiles the information contained in three Technical Memoranda pertaining to the development of Measures of Performance (MOP) for Multi-Sensor Data Fusion technology (MSDF), and evaluates logistics and the utility of the Operations Room Team Trainer (ORTT) to gather these MOPs. Each Technical Memorandum is preceded by a summary of its content. This report recounts the development of a strategy for collection of MOPs, the conduct of a proof-of-concept trial at ORTT (with attendant identification of potential improvements to the data collection strategy), and the investigation of methods to reduce the logistical and availability problems associated with obtaining access to Subject Matter Experts (SME). As a result of this work, a further, full-scale, investigation of the archived ORTT performance data to provide performance data for the COMDAT Technology Demonstration Programme was recommended.

(U) Le présent rapport comprend une compilation de l'information contenue dans trois documents techniques portant sur l'élaboration de mesures du rendement de la technologie de la fusion de données multicapteurs (FDMC), ainsi qu'une évaluation de la logistique et de l'utilité du simulateur pour l'équipe de la salle des opérations (SESO) en vue de la collecte des mesures du rendement. Chaque document technique est précédé d'un résumé de son contenu. Le présent rapport récapitule l'élaboration d'une stratégie de collecte des mesures du rendement, la conduite de l'essai de validation de principe au SESO (l'opérateur identifiant les améliorations possibles à apporter à la stratégie de collecte des données) et l'examen des méthodes visant une réduction des problèmes de logistique et de disponibilité associés à l'accès aux experts en la matière (EM). Suite à ce travail, un autre examen pleine échelle des données archivées sur le rendement du SESO a été recommandé en vue de la fourniture de données sur le rendement dans le cadre du programme de démonstration de la technologie d'aide aux décisions de commandement (COMDAT).

15. KEYWORDS, DESCRIPTORS or IDENTIFIERS

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